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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

in

VLSI Design & Technology

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 VLSI Design & Technology 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 VLSI Design & Technology 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 VLSI Design & Technology 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 Honors** in chosen Major Engg./ Tech. Discipline i.e. in VLSI Design & Technology Engineering with Honors with Multidisciplinary Minor (180-194 credits) enables students of VLSI Design & Technology Engineering to take up five-six additional courses of 18 to 20 credits in the VLSI Design & Technology 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 VLSI Design & Technology Engineering with Research with Multidisciplinary Minor (180-194 credits) enables students of VLSI Design & Technology Engineering to take up a research project of 18 to 20 credits in the VLSI Design & Technology 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 VLSI Design & Technology 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 VLSI Design & Technology 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 Prerequisites:

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 up to <5.50	Pass class
CGPA ≥ 5.50 &<6.00	Second Class
CGPA ≥ 6.00 &<7.50	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, 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 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 (up to 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 (e.g. 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 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 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 must 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 the 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
	2311378BS200	Engineering Mathematics-III	3	0	0	3	BSC
SEM III	2311378PC201	Digital Electronics	3	0	0	3	PCC
	2311378PC201L	Digital Electronics Lab	0	0	2	1	PCC Lab
	2311378PC203	Network Theory	3	0	0	3	PCC
	2311378PC203L	Network Theory Lab	0	0	2	1	PCC Lab
	2311378MD201	**MDM Bucket***	2	0	0	2	MD Minor
	2311378OE201	**Open Elective Bucket****	2	0	0	2	OE
	2311378AE201	Employability and Skill Development	2	0	0	2	Entrepreneurship
	2311378AE203	Universal Human Values II	3	0	0	3	VEC
	2311372AE205	Life of Chhatrapati Shivaji Maharaj	1	0	0	1	VEC
	2311378FP201	Community Engineering Project (CEP)	0	0	4	2	CEP/FP
			19	**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	2311378PC202	Electronic Devices & Circuits	3	0	0	3	PCC
	2311378PC202L	Electronic Devices & Circuits Lab	0	0	2	1	PCC Lab
	2311378PC204	System Design through Verilog	3	0	0	3	PCC
	2311378PC204L	System Design through Verilog Lab	0	0	2	1	PCC Lab
	2311378PC206	Microprocessor	3	0	0	3	PCC
	2311378PC206L	Microprocessor Lab	0	0	2	1	PCC Lab
	2311378MD202	**MDM Bucket***	2	0	0	2	MD Minor
	2311378OE202	**Open Elective Bucket****	3	0	0	3	OE
	2311378SE202	PCB Designing	0	0	4	2	VSEC
	2311378AE204	Marathi/Hindi/Sanskrit/Gujrati/Kannada	2	0	0	2	HSSM
	2311378AE206	Patents and IPR	2	0	0	2	Entrepreneurship
	2311378AE208	Constitution of India	2	0	0	AU	VEC
	2311378AE210	Life of Bharatratna Dr. Babasaheb Ambedkar	1	0	0	1	VEC
			19	**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	2311378PC307	Basic VLSI Design	3	1	0	4	PCC
	2311378PC307L	Basic VLSI Design Lab	0	0	2	1	PCC Lab
	2311378PC309	Embedded system design	3	1	0	4	PCC
	2311378PC309L	Embedded system design Lab	0	0	2	1	PCC Lab
	2311378PC311	IC Packaging	3	0	0	3	PCC
	2311378PE301	A. Semiconductor Technologies B. Control System C. Signals & Systems	3	0	0	3	PEC
	2311378MD303	**MDM Bucket***	3	1	0	4	MD Minor
	2311378OE303	**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
	2311378PC308	Digital System Design using VHDL	3	0	0	3	PCC
	2311378PC308L	Digital System Design using VHDL Lab	0	0	2	1	PCC Lab
SEM VI	2311378PC310	Analog & Digital Communication	3	0	0	3	PCC
	2311378PC310L	Analog & Digital Communication Lab	0	0	2	1	PCC Lab
	2311378PE302	A. Nanoelectronics B. Digital Image Processing C. Introduction to VLSI lifecycle	3	0	0	3	PEC
	2311378PE304	A. Microelectronics B. Low Power VLSI Circuits & Systems C. Wireless Sensor Networks	3	0	0	3	PEC
	2311378MD304	**MDM Bucket***	2	0	0	2	MD Minor
	2311378SE304	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
	2311378PC313	Analog CMOS VLSI Design	3	0	0	3	PCC
	2311378PC313L	Analog CMOS VLSI Design Lab	0	0	2	1	PCC Lab
SEM VII	2311378PC315	VLSI Circuits	3	0	0	3	PCC
	2311378PE403	A. Biomedical Electronics B. Computer Networks C. VLSI Design Flow: RTL to GDS	3	0	0	3	PEC
	2311378PE405	A. Antenna & Wave propagation B. Neural Networks & Fuzzy logic C. Information Theory & coding	3	0	0	3	PEC
	2311378MD405	**MDM Bucket***	2	0	0	2	MD Minor
	2311378RM401	Research Methodology	3	1	0	4	RM
	2311378PR401	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	2311378PC312	CMOS Digital VLSI Design	3	0	0	3	PCC
	2311378PE406	A. Data Structure & Algorithms Using Java Programming B. UAV in Engineering Applications C. SOC Design: Design & Verification	2	0	0	2	PEC
	2311378MD406	**MDM Bucket***	2	0	0	2	MD Minor
	2311378IT401	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 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.

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
35	**70**	**22**	**9**	**16**	**22**	**4**	**178**

SEMESTER III

2311378BS200	Engineering Mathematics-III	03 Credits

Course Objectives:

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-magnetic 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 analysing 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, analyse the vector fields, and apply to Electromagnetic fields.
CO5: Analyse conformal mappings, transformations and perform contour integration of complex functions in the study of electrostatics and signal processing.

Unit 1: Laplace Transform **9 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 **9 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 **9 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 9 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 9 Hours

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs).

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
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, New York.
2. A Text Book of Engineering Mathematics by Peter O'Neil, Thomson Asia Pte Ltd., Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
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, New York.

2311378PC201	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: Became familiar with the digital signal, positive and negative logic, Boolean algebra, logic gates, logical variables, the truth table, number systems, codes, and their conversion from to others.

CO2: Learn the minimization techniques to simply the hardware requirements of digital circuits, implement it, design and apply for real time digital systems.

CO3: Understand the working mechanism and design guidelines of different combinational, sequential circuits and their role in the digital system design.

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

Unit 1: Introduction

Logic gates (AND, OR, NOT, XOR, XNOR, NAND, NOR) Switching functions, Boolean algebra – axioms and laws, De-Morgan's theorem, Min term, Max term, , k map representation of logic functions (SOP and POS forms), Quine-McCluskey's method, Simplification by Boolean theorems, don't care condition.

Unit 2: Number systems & representation

Number system and codes: Binary, octal, hexadecimal, and decimal Number systems and their inter conversion, BCD numbers (8421-2421), gray code, excess–3 code, cyclic code, code conversion, ASCII, EBCDIC codes. Binary addition and subtraction, signed and unsigned binary numbers, 1's and 2's complement representation.

Unit 3: Combinational Logic Design

Adder Circuit, Subtractor Circuit. Design of Multiplexer, Demultiplexer, Decoder, Encoders, Digital Comparator

Unit 4: Sequential Logic Design

Flip flop and Timing circuit: set-reset laches, D-flipflop, R-S flip-flop, J-K Flip-flop, Master slave Flip flop, edge triggered flip-flop, T flip-flop. Registers & Counters: Synchronous/Asynchronous counter operation ,Up/down synchronous counter, shift registers, Mealy and Moore machines

Unit 5: Digital Logic Families

Brief overview of Transistor as a switch; Logic gate characteristics – propagation delay, speed, noise margin, fan-out and power dissipation; Standard TTL and static CMOS gates. ROM and RAM, PLA, PAL and FPGA

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. Douglas Perry, ―VHDL, Tata McGraw Hill, 4th edition, 2002.
5. W.H. Gothmann, ―Digital Electronics- An introduction to theory and practice‖, PHI, 2nd edition ,2006.
6. D.V. Hall, ―Digital Circuits and Systems‖, Tata McGraw Hill, 1989

2311378PC201L	Digital Electronics Lab	01 Credits

List of Experiments:

1. Study of Logic gates and their ICs and universal gates.
2. Implement all gates using universal gates.
3. Implementation of the Given Boolean Function using Logic Gates.
4. Design and implement adder and subtractor.
5. Design and implement comparator.
6. Implementation and verification of truth table of 4x1 Multiplexer and 1x4 Demultiplexer.
7. Implementation and verification of truth table of encoder and Decoder.
8. Verification of State Tables of RS, J-K, T and D Flip-Flops
9. Study Of Counters.
10. Design of 4-bit shift register.

2311378PC203	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: Explain basic electrical circuits with nodal and mesh analysis and apply network theorems.
CO2: Apply Laplace Transform for steady state and transient analysis.
CO3: Determine different network functions and solve complex circuits using network parameters.
CO4: Realize electrical networks for given network functions using synthesis concepts.
CO5: Design various types of filters.

Unit 1: Analysis of circuits **6 Hours**

Analysis of DC circuits using dependant sources; Mesh, Supermesh, Node, Supernode analysis, Superposition, Thevenin, Norton's and Maximum Power Transfer theorems. Use of source transformation.

Analysis of coupled circuits; Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using loop analysis.

Unit 2: Transient Analysis and Frequency Domain Analysis **6 Hours**

Transient Analysis: Forced and natural response, Initial and final conditions in network elements, Solution of first and second order differential equations for series and parallel R-L, R-C, R-L-C circuits, Transient and steady state response.

Frequency Domain Analysis: S-domain representation, Concept of complex frequency, Applications of Laplace Transform in solving electrical networks.

Unit 3: Two Port networks **6 Hours**

Network functions; Driving point and Transfer Function, Poles and Zeros, Analysis of ladder networks.

Two Port Parameters: Open circuit, short circuit, Transmission and Hybrid parameters, relationships among parameters, reciprocity, and symmetry conditions.

Unit 4: Synthesis of Electrical networks **6 Hours**

Realizability Concept: Hurwitz polynomial, Concept of positive real function, testing for necessary and sufficient conditions for positive real functions.

Synthesis of RC, RL, LC circuits: Concepts of synthesis of RC, RL, LC driving point functions, Foster and Cauer forms.

Unit 5: Introduction to filters **6 Hours**

Basic filter circuits: Low pass, high pass, band pass and band stop filters, cut-off frequency, bandwidth, quality factor, attenuation constant, phase shift, characteristic impedance.

Design and analysis of filters: Constant K filters

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.

2311378PC206L	Network Theory Lab	03 Credits

List of Experiments:

1. Thevenin’s, Norton’s and Maximum Power Transfer Theorems
2. Superposition Theorem
3. Reciprocity and Millman’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. Simulation of DC Circuits
9. Mesh Analysis
10. Nodal Analysis
11. DC Transient response

2311378AE201	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.
CO2. Be equipped with essential communication skills (writing, verbal and non-verbal)
CO3. Master the presentation skill and be ready for facing interviews.
CO4. 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.

2311378AE203	Universal Human Values II	02

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:

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

CO1: The students start exploring themselves: get comfortable with each other and with the teacher; they start appreciating the need and relevance for the course.

CO2: The students can see that all physical facility they are required for a limited time in a limited quantity. Also, they can see that in case of feelings, they want continuity of the naturally acceptable feelings and they do not want feelings which are not naturally acceptable even for a single moment.

CO3: The students can note that the natural acceptance (intention) is always for living in harmony, only competence is lacking! The students can see that respect is right evaluation, and only right evaluation leads to fulfillment in relationship. Many present problems in the society are an outcome of differentiation (lack of understanding of respect), like gender biasness, generation gap, caste conflicts, class struggle, dominations through power play, communal violence, clash of isms and so on so forth.

CO4: The students can differentiate between the characteristics and activities of different orders and study the mutual fulfillment among them.

CO5: The students can present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them.

Unit 1 Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1: Understanding Value Education

Lecture 2: Self-exploration as the Process for Value Education

Tutorial 1 Practice Session PS1 Sharing about Oneself

Lecture 3: Continuous Happiness and Prosperity the Basic Human Aspirations

Lecture 4: Right Understanding, Relationship and Physical Facility

Tutorial 2: Practice Session PS2 Exploring Human Consciousness

Lecture 5: Happiness and Prosperity Current Scenario

Lecture 6: Method to Fulfill the Basic Human Aspirations

Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

Unit 2 Harmony in the Human Being (6 lectures and 3 tutorials for practice session)

Lecture 7: Understanding Human being as the Co-existence of the Self and the Body
Lecture 8: Distinguishing between the Needs of the Self and the Body
Tutorial 4: Practice Session PS4 Exploring the difference of Needs of Self and Body
Lecture 9: The Body as an Instrument of the Self
Lecture 10: Understanding Harmony in the Self
Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the Self
Lecture 11: Harmony of the Self with the Body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 Exploring Harmony of Self with the Body

Unit 3 Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

Lecture 13: Harmony in the Family the Basic Unit of Human Interaction
Lecture 14: Values in Human-to-Human Relationship
Lecture 15: 'Trust' the Foundational Value in Relationship
Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust
Lecture 16: 'Respect' as the Right Evaluation
Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

Unit 4 Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence

Unit 5 Implications of the Holistic Understanding a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Text Book and Teachers Manual

a. The Textbook

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

2311378PC202	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 its 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:

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

CO1: Explain working of semiconductor devices.
CO2: Analyse characteristics of semiconductor devices.
CO3: Perform DC and AC analysis of Electronics circuits.
CO4: Compare various biasing circuits as well as various configurations of BJT and MOSFETs.
CO5: Select best circuit for the given specifications/application.
CO6: Design electronics circuits for given specifications.

Unit 1: PN junction diode **6 Hours**

Fermi level concepts, basic diode structures, energy band diagrams, zero applied bias, forward & reverse biased diode, drift and diffusion currents, depletion & diffusion capacitance, small signal model, applied forward bias, applied reverse bias, temperature effects. I-V characteristics.

Unit 2: Diode applications & special semiconductor devices **6 Hours**

Clippers and Clampers, Zener as voltage regulator.
Construction, Working and Characteristics of: Schottky diode, Solar Cells, Photodiodes, LEDs.

Unit 3: Bipolar Junction Transistor **6 Hours**

BJT operations, voltages, and currents, BJT characteristics (CE, CB, CC configurations), early effect. DC Circuit Analysis: DC load line and region of Operation, Common Bipolar Transistor Configurations, biasing circuits, bias stability and compensation, analysis, and design of biasing circuits. AC Analysis of BJT Amplifiers: AC load line, small signal models: h-parameter model, re model, Hybrid-pi model. AC equivalent circuits and analysis to obtain voltage gain, current gain, input impedance, output impedance of CE, CB and CC amplifiers using Hybrid-pi model only.

Unit 4: Field Effect Devices **6 Hours**

JFET: Construction, operation, and characteristics. MOSFET: Construction, operation, and characteristics of D-MOSFET and E-MOSFET.

DC Circuit Analysis: DC load line and region of operation, Common-MOSFETs configurations, Analysis and Design of Biasing Circuits

AC Analysis: AC load line, Small-Signal model of MOSFET and its equivalent Circuit, Small Signal Analysis MOSFET Amplifiers (Common-Source, Source Follower, Common Gate)

Unit 5: Design of Electronic circuits **6 Hours**

Rectifiers: Working and analysis of Full wave and Bridge, Filters: C, L, LC, pi.

Design of single stage CE amplifier, Design of single stage CS MOSFET amplifier, Design of full wave rectifier with LC and pi filter.

2311378PC202L	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.

2311378PC204	System Design through Verilog	03 Credits

Course Objectives:

1. To know the basic language features of Verilog HDL and the role of HDL in digital logic design.
2. To know the behavioural modeling of combinational and simple sequential circuits.
3. To know the behavioral modeling of algorithmic state machines.
4. To know the synthesis of combinational and sequential descriptions.
5. To know the architectural features of programmable logic devices.

Course Outcomes:

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

CO1. Demonstrate knowledge on HDL design flow, digital circuits design, switch de-bouncing, metastability, memory devices applications
CO2. design and develop the combinational and sequential circuits using behavioral modelling
CO3. solving algorithmic state machines using hardware description language
CO4. analyze the process of synthesizing the combinational and sequential descriptions
CO5. memorizing the advantages of programmable logic devices and their description in Verilog

Unit 1

Introduction to Logic Design with Verilog: Structural models of combination logic, logic simulation, design verification, test methodology, propagation delay, truth table models of combinational and sequential logic with Verilog modules, ports, gate types, gate delays, dataflow modelling, continuous assignments delays, expressions, operators, operands, operator types

Unit 2

Logic Design with Behavioral Models of Combinational and Sequential Logic: Behavioral modeling, data types for behavioral modeling, behavioral models of combinational logic, propagation delay and continuous assignments, lathes and level sensitive circuits in Verilog, cyclic behavioural models of flip flops and latches, cyclic behavior and edge detection, a comparison of styles for behavioral modeling

Unit 3

Behavioral models of multiplexers, encoders and decoders data flow model of a lfsr machines with multicycle operations, algorithmic state machine charts for behavioral modeling, asmd charts, behavioural models of counters, shift registers and register files, switch debounce, metastability, synchronizers for asynchronous signals.

Unit 4

Introduction to synthesis: synthesis of combinational logic, synthesis of sequential logic with latches, synthesis of three state devices and bus interfaces, synthesis of sequential logic with flip flops, synthesis of explicit state machines registered logic

.

Unit 5

Programmable logic devices, storage devices, programmable logic array programmable array logic, programmability of PLDs CPLDs.

Text/Reference Books:

1. Michael D Ciletti - Advanced Digital Design with the VERILOG HDL, 2ND Edition, PHI, 2009.
2. Samir Palnitkar - Verilog HDL, 2nd edition, Pearson Education, 2003.

3. Stephen Brown and Zvonko Vranesic - Fundamentals of Digital Logic with Verilog, 2nd Edition, TMH, 2008.
4. Z Navabi - Verilog Digital System Design, 2nd Edition, McGraw Hill, 2005.

2311378PC204L	System Design through Verilog Lab	01 Credits

1. Simulation using all the modeling styles and Synthesis of all the logic gates using Verilog HDL.
2. Design of 2-to-4 decoder
3. Design of 8-to-3 encoder (without and with priority)
4. Design of 8-to-1 multiplexer and 1-to-8 demultiplexer
5. Design of 4 bit binary to gray code converter
6. Design of 4-bit comparator
7. Design of Full adder using 3 modeling styles
8. Design of flip flops: SR, D, JK, T
9. Design of 4-bit binary, BCD counters (synchronous/ asynchronous reset) or any sequence counter
10. Finite State Machine Design

2311378PC206	Microprocessors	03 Credits

Course objectives:

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

Course Outcomes:

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

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 **6 Hours**

Basic 8085 microprocessor architecture and its functional blocks, 8085 microprocessor IC pin outs and signals.

Unit 2: Programming with 8085 **6 Hours**

Assembly Language Programming Basics, Addressing Modes, Instruction set of microprocessors, Instruction timing diagram. Writing, Assembling & Executing Assembly Language Programs.

Unit 3: Interrupts **6 Hours**

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 **6 Hours**

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

Unit 5: Introduction of 8086 Microprocessor **6 Hours**

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 edition, Pearson education.
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., Mallikarjuna Swamy, 8051 Microcontroller, MH.
7. K. J. Ayala, 8051 microcontroller, Cengage (Thomson).

2311378PC206L	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

2311378SE202	PCB Designing	02

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.

2311378AE204	Marathi/Hindi/Sanskrit/Gujarati/Kannada	02 Credits

2311378AE206	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.

2311378AE208	Constitution of India	02 Credits

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.

Unit 1: Introduction and Basic Information about Indian Constitution:

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947,Enforcement of the Constitution, Indian Constitution and its Salient Features, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

Unit 2: Union Executive and State Executive:

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges, Judicial Review, Public Interest Litigation, Judicial Activism, LokPal, Lok Ayukta, The Lokpal and Lok ayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Unit 3: Introduction and Basic Information about Legal System:

The Legal System: Sources of Law and the Court Structure: Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law, Principles taken from decisions of judges constitute binding legal rules. The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court). Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration. Contract law, Tort, Law at workplace.

Unit 4: Intellectual Property Laws and Regulation to Information:

Intellectual Property Laws- Introduction, Legal Aspects of Patents, Filing of Patent Applications, Rights from Patents, Infringement of Patents, Copyright and its Ownership, Infringement of Copyright, Civil Remedies for Infringement, Regulation to Information-Introduction, Right to Information Act, 2005, Information Technology Act, 2000, Electronic Governance, Secure Electronic Records and Digital Signatures, Digital Signature Certificates,

Cyber Regulations Appellate Tribunal, Offences, Limitations of the Information Technology Act.

Unit 5: Business Organizations and E-Governance:
Sole Traders, Partnerships: Companies: The Company's Act: Introduction, Formation of a Company, Memorandum of Association, Articles of Association, Prospectus, Shares, Directors, General Meetings and Proceedings, Auditor, Winding up. E-Governance and role of engineers in E-Governance, need for reformed engineering serving at the Union and State level, Role of I.T. professionals in Judiciary, Problem of Alienation and Secessionism in few states creating hurdles in Industrial development.

Text/Reference Books:
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
12. https://www.icsi.edu/media/webmodules/publications/Company%20Law.pdf
13. 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
14. Companies Act, 2013 Key highlights and analysis by PWC.
15. 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. Shivkant Shakla, 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

2311378PC307	Basic VLSI Design	04 Credit

Course Objectives:

1. To understand VLSI Design flow and technology trends.
2. To realize MOS based circuits using different design styles.
3. To study semiconductor memories using MOS logic.
4. To study adder, multiplier, and shifter circuits for realizing data path design.

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

CO1: Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
CO2: Design and analyze MOS based inverters.
CO3: Understand different MOS circuit design styles.
CO4: Apply design styles for realization of Combinational and Sequential Circuits
CO5: Understand various semiconductor memories using MOS logic
CO6: Design adder, multiplier and shifter circuits using MOS logic

Unit 1: VLSI Design flow **7 Hours**

VLSI Design Flow: Full custom and Semicustom IC design flow, MOSFET Scaling: Types of scaling, comparison of MOSFET Model levels, MOSFET capacitances, interconnect scaling and crosstalk, Technology Comparison: Comparison of BJT and MOS technologies.

Unit 2: MOSFET Inverters **7 Hours**

Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison, Static Analysis of Resistive nMOS and CMOS Inverters: Calculation of critical, voltages and noise margins, Design of symmetric CMOS inverter Dynamic Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay, Various components of power dissipation in CMOS circuits.

Unit 3: MOS Circuit Design styles **5 Hours**

Static: Static CMOS, Pass transistor, Transmission gate, Pseudo NMOS design Styles, Dynamic: C^2MOS, Dynamic, Domino, NORA, and Zipper design styles.

Unit 4: Combinational and Sequential Circuit Realization **9 Hours**

Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realisation using equivalent CMOS inverter for simultaneous switching, Complex Boolean function realisation using various design styles, Basic gates and MUX realisation using pass transistor

and transmission gate logic, SR Latch, JK FF, D FF, 1 Bit Shift Register realisation using CMOS logic.

Unit 5: Data path Design **7 Hours**

Adder: CLA adder, MODL, Manchester carry chain, High-speed adders: carry skip, carry select and carry save, Multipliers and shifter: Array multiplier and barrel shifter.

Text/Reference Books:

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design" Tata McGraw Hill, Revised 4th Edition.
2. John P. Uyemura, "Introduction to VLSI Circuits and Systems", Wiley India Pvt. Ltd.
3. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition
4. Douglas A Pucknell, Kamran Eshraghian, "Basic VLSI Design", Prentice Hall of India Private Ltd.
5. Ivan Sutherlan and Bob Sproull, "Logical Effort: Designing Fast CMOS Circuits"

2311378PC307L	Basic VLSI Design Lab	01 Credit

List of experiments:

1. To write SPICE code for obtaining Transfer Characteristics (Id-Vg) and Output characteristics (Id-Vd) of enhancement and depletion type nMOS and pMOS transistors and extract parameter like subthreshold leakage current (IL), threshold voltage (VT0) and Subthreshold Swing (SS).
2. To study the impact of MOSFET Model parameters in Level1 / Level2 on the drain characteristics.
3. To study the Voltage Transfer Characteristics (VTC) of resistive Load nMOS inverter and calculate high and low noise margins by extracting critical voltages. Also study the impact of variation of load resistance on VTC and hence on the noise margin.
4. To analyse the transient performance of CMOS inverter.
5. To realise the complex Boolean function using different design styles.
6. To realise Basic gates / MUX circuits using Pass transistor /Transmission gate logic.
7. To realise SR Latch, JK FF, D FF using MOS logic.
8. To realise SRAM /DRAM using MOS logic.

Course Objectives

1. Differentiate Embedded and General Computing Systems: Understand the key distinctions
between embedded systems and general-purpose computing systems.

2. Master Embedded C Programming: Develop proficiency in Embedded C, including data types, structures, and optimization techniques.

3. Understand ARM Processor Fundamentals: Gain detailed knowledge of ARM architecture, instruction sets, and interrupt handling.

4. Implement Communication Protocols: Learn and apply various communication protocols such as UART, I2C, SPI, and CAN in embedded systems.

5. Grasp RTOS Fundamentals: Understand the core concepts of Real-Time Operating Systems, including multitasking, memory management, and task scheduling.

Course Outcomes

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

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

3. ARM Architecture Proficiency: Students will demonstrate proficiency in ARM processor architecture and programming, including exception and interrupt handling.

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

5. 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

Embedded system vs general Computing system. Classification of Embedded system. Core of Embedded system. RISC vs CISC controllers. Harvard vs Van Neumen architecture, Architecture of Embedded System, Design Methodology, Design Metrics.

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: ARM processor fundamentals

ARM Processor Families, Registers, Current Program Status Registers (CPSR), Pipeline, exceptions, Interrupts and the vector table, Data Processing Instruction, Branch Instruction, LoadStore Instructions, Software Interrupts instructions, Program Status Register Instructions, Loading Constants, Thumb register usage, ARM-Thumb Interworking, Stack instructions.

Unit IV: Communication protocols
Use of communication protocols in embedded systems, Serial communication basics, synchronous/asynchronous interfaces, UART Protocol, I2C protocol, SPI protocol, USB Protocol, SPI protocol, CAN Protocol, 1 Wire protocol.

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

2311378PC309L	Embedded System Design Lab	04 Credit

2311378PC311	IC Packaging	03 Credits

Course Outcomes:
1: Understand the relevance of packaging for electronic systems
2: Elaborate various materials and techniques used in electronic packaging
3: Inspect electronic package for reliability, thermal management and testability.

Unit 1: Introduction to IC Packaging Technologies
Overview of IC packaging and its significance. Historical context and evolution of packaging technologies. Introduction to packaging types: through-hole, surface-mount, ball grid array.

Unit 2: Packaging Materials and Interconnection Techniques
Study of materials used in semiconductor packaging. Interconnection techniques: wire bonding, flip-chip, and solder bump technologies.

Unit 3: Thermal Management in IC Packaging
Principles of thermal management in IC packaging. Techniques for heat dissipation and cooling, Signal integrity challenges in IC packaging, Power integrity considerations and solutions.

Unit 4: Packaging Types and Trade-offs
In-depth study of through-hole, surface-mount, and ball grid array packaging, Trade-offs involved in selecting packaging types.

Unit 5: Reliability in IC Packaging
Factors affecting reliability in IC packaging, Testing and validation techniques for packaged ICs, Advanced Topics in IC Packaging, Emerging trends in IC packaging technologies.

Recommended Books

1. John H. Lau. Semiconductor Advanced Packaging. Springer, 2021.
2. King-Ning Tu, Chih Chen, Hung-Ming Chen. Electronic Packaging Science and Technology.
John Wiley and Sons Inc., 2022.

2311378PE301A	Semiconductor Technologies	03 Credits

Course Objectives:

1. To familiarize students with basic semiconductor physics
2. To introduce students to semiconductor device fabrication
3. To teach students how MEMS technology works
4. To understand semiconductor memories

Course Outcomes:

CO1: Discuss integrated circuit fabrication processes and use modern/open-source tools for process simulation.
CO2: Apply the sequence of fabrication processes and design rules for layout design and characterization of a given semiconductor device/MOS circuit.
CO3: Discuss fundamental principles of MEMS devices including physical operation and mathematical modeling.
CO4: Apply various fabrication processes, choose suitable materials for MEMS device FEM modeling, fabrication, and characterization.
CO5: Discuss fundamental principles and fabrication process steps for semiconductor memories and displays.

Unit 1: Environment and crystal growth for VLSI Technology 7 Hours

Environment: Semiconductor technology trend, clean rooms, Semiconductor Substrate: Phase diagram and solid solubility, Crystal structure, Crystal defects, Czochralski growth, Bridgman growth of GaAs, Float Zone growth, Wafer Preparation, and specifications.

Unit 2: Fabrication Process part 1 7 Hours

Cleaning of Silicon wafer, Deposition: Evaporation, Sputtering and Chemical Vapor Deposition. Epitaxy: Molecular Beam Epitaxy, Vapor Phase Epitaxy, Liquid, Phase Epitaxy, Evaluation of epitaxial layers, Silicon Oxidation: Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality, high κ and low κ dielectrics.
Diffusion: Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, impurity behavior, diffusion systems, problems in diffusion, evaluation of diffused layers.
Ion Implantation: Penetration range, ion implantation systems, process considerations, implantation damage and annealing.

Unit 3: Fabrication Process part 2 **7 Hours**

Etching: Wet chemical etching, dry physical etching, dry chemical Lithography: Photoreactive materials, Pattern generation and mask making, pattern transfer, Electron beam, Ion beam and X-ray lithography.

Device Isolation, Contacts and Metallization: Junction and oxide isolation, LOCOS, trench isolation, Schottky contacts, Ohmic contacts, Metallization and Packaging: Integrated circuit packages, Electronics package reliability

CMOS Process Flow: N well, P-well and Twin tub 2 Design rules, Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact.

Unit 4: MEMS Technology **7 Hours**

Introduction to MEMS Technology, Difference between ICT & MEMS Technology, Difference between ICs and MEMS Devices and Real world Sensors/Actuators examples with brief description, Bulk, Surface & LIGA Micromachining, Die, Wire & Wafer Bonding, Dicing, Packaging.

Materials (eg. Si, SiO2, SiN, SU8, PMMA); Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure.

Unit 5: Semiconductor Memories **7 Hours**

Memory: SRAM, DRAM, MRAM, Flash: Working Principle, structures, and fabrication steps of one/two memory structures.

Display: AMOLED/OLED: Working Principle, structures,
fabrication steps

Text/Reference books:

1. James D. Plummer, Michael D. Deal, and Peter B. Griffin, Silicon VLSI Technology, Indian Edition First, Pearson, 2000
2. G. S. May and S. M. Sze, Fundamentals of Semiconductor Fabrication, Wiley, 2011
3. A.K. Sharma, Semiconductor Memories Technology, Testing and Reliability, IEEE 2022
4. Frontiers in Electrical Engineering Vol. 1: Active-Matrix Organic Light-Emitting Display, Technologies, Shuming Chen, Jianning Yu, Yibin Jiang, Rongsheng Chen, Tsz Kin Ho, Bentham Books, 2015

2311378PE301B	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.

Unit 1: Introduction to control problem **7 Hours**

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.

Unit 2: Time Response Analysis and Stability Analysis **7 Hours**

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.

Unit 3: Frequency-response analysis **7 Hours**

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.

Unit 4: Introduction to Controller Design **7 Hours**

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 Bode Plot.

Unit 5: State variable Analysis **7 Hours**

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 discrete time systems.

Text/Reference Books:

1. N. J. Nagrath and M. Gopal, “Control System Engineering,” New Age International Publishers, 5th Edition, 2009.

2. Benjamin C. Kuo, “Automatic control systems,” Prentice Hall of India, 7th Edition, 1995.
3. M. Gopal, “Control System – Principles and Design,” Tata McGraw Hill, 4th Edition, 2012.
4. Schaum’s Outline Series, “Feedback and Control Systems” TataMcGraw-Hill,2007.
5. John J. D’Azzo & Constantine H. Houpis, “Linear Control System Analysis and Design,” Tata McGraw-Hill, Inc.,1995.
6. Richard C. Dorf and Robert H. Bishop, “Modern Control Systems,” Addison – Wesley, 1999.

2311378PE301C	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 **7 Hours**

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 **7 Hours**

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 **7 Hours**

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 **7 Hours**

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 **7 Hours**

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, Wiley India.
4. Shaila Apte, “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. Roberts, M.J., “Fundamentals of Signals & Systems,” Tata McGraw Hill. 2007.
8. Ziemer, R.E., Tranter, W.H. and Fannin, D.R., “Signals and Systems: Continuous and Discrete,” 4th 2001 Ed., Pearson Education.

SEMESTER VI

2311378PC308	Digital System Design using VHDL	03 Credits

Course Objectives:

1. To understand, analyze & design finite state machines (FSM)
2. To train students in writing VHDL code of combinational & sequential circuits
3. To prepare students to design FSM using hardware description languages (HDL)
4. To motivate students to use reconfigurable devices for digital systems.

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

CO1: Analyze & design FSM.
CO2: Understand fundamentals of HDL and its use for designing combinational circuits.
CO3: Apply the concept of HDL for designing sequential circuits.
CO4: Develop FSM by using the fundamentals of HDL.
CO5: Design of complex digital systems.
CO6: Understand and distinguish FPGA and CPLD architecture.

Unit 1: State Machine Design **6 Hours**

Mealy and Moore machines, clocked synchronous state machine design, state reduction techniques, State assignment, Clocked synchronous state machine analysis. Design examples on overlapping and non-overlapping sequence detector, Odd/even parity checker for serial data, vending machines.

Unit 2: Introduction to VHDL **6 Hours**

Core features of VHDL, Data types, Concurrent and Sequential statements, Data flow, Behavioral and Structural architectures, Subprograms: Function and Procedure.
Design examples of combinational circuits like Multiplexers, De-multiplexers, Adder, Subtractor, Priority Encoder.

Unit 3: Design of sequential circuit using VHDL **6 Hours**

Design examples for Flip flops, Synchronous counters, Asynchronous counters, Shift registers.

Unit 4: Design of Finite State Machines (FSM) using VHDL **6 Hours**

VHDL code for Moore, Mealy type FSMs, Serial adders, Traffic light controller, Vending machines.

Unit 5: System Design using VHDL **6 Hours**

Parallel Multiplication, Booth Multiplication, MAC unit, ALU, Memory: ROM and RAM
CPLD, SRAM based FPGA architecture, Spartan II.

Text/Reference books:

1. Volnei A. Pedroni, “Circuit Design with VHDL” MIT Press, 2004.
2. Wayne Wolf, “FPGA Based System Design” Pearson Education.
3. M. Morris Mano, “Digital Design,” 5th Edition, Pearson Education India, 2012.
4. P. J. Ashenden, “The students guide to VHDL” Elsevier,1999.
5. R. P. Jain, “Modern Digital Electronics,” 4th Edition, McGraw Hill Education, 2016.

2311378PC308L	Digital System Design using VHDL Lab	01 Credit

List of Experiments:

1. Write VHDL code for various Combinational circuits also write test bench for simulation
2. Write VHDL code for various Sequential circuits also write test bench for simulation
3. Write VHDL code for Mealy & Moore’s type FSM’s
4. Write VHDL code for serial adders
5. Write VHDL code for traffic light controller
6. Write VHDL code for vending machine
7. Write VHDL code for ALU
8. Write VHDL code for ROM

2311378PC310	Analog & Digital Communication	03 Credits

Course Objectives:

1. To study the fundamental concept of the analog communication systems.
2. To analyze various analog modulation and demodulation techniques.
3. To know the working of various transmitters and receivers.
4. To understand the influence of noise on the performance of analog communication systems.
5. To acquire the knowledge about information and capacity.

Course Outcomes:

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

CO1. Analyze and compare different analog modulation schemes for their efficiency and bandwidth

CO2. Analyze the behavior of a communication system in presence of noise

CO3. Investigate pulsed modulation system and analyze their system performance

CO4. Analyze different digital modulation schemes and can compute the bit error performance

UNIT – 1

Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

UNIT – 2

Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.

UNIT – 3

Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers

UNIT – 4

Elements of Detection Theory, Optimum detection of signals in noise, Coherent Communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.

UNIT – 5

Digital Modulation tradeoffs. Optimum demodulation of digital signals over band-limited channels Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation

TEXT/REFERENCE BOOKS

1. Haykin S., "Communications Systems", John Wiley, and Sons, 2001.

2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.

3. Taub H. and Schilling D.L., "Principles of Communication Systems‖, Tata McGraw Hill,

4. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering",John Wiley,1965.

5. Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication'', Kluwer Academic Publishers, 2004.

6. Proakis J.G., ``Digital Communications'', 4th Edition, McGraw Hill, 2000.

7. R. Anand, Communication Systems, Khanna Book Publishing Company, 2011.

2311378PC310L	Analog & Digital Communication Lab	01 Credits

List of Experiments:

2311378PE302A	Nano Electronics	04

Course Objectives:

1. To convey the basic concepts of Nano electronics to engineering students with no background in quantum mechanics.
2. Main objective is to provide the basic platform and information of different Nano electronics devices like MOSFET, finFET.
3. To understand basic semiconductor band theory.
4. To understand quantum well, quantum dots, quantum tunneling, Coulomb Blockade, and SET

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

CO1: Analyse and apply Schrodinger's wave equation.
CO2: Understand band theory of solids.
CO3: Understand CMOS scaling and physical limits to it.
CO4: Understand quantum dots, Coulomb Blockade, quantum tunneling.
CO5: Understand working of nano devices Resonant tunneling diode, Single Electron Transistor, Carbon Nanotubes, finFET's, Vertical MOSFET's.

Unit 1: Overview Nano Technology and Basics of Quantum Mechanics 7 Hours
Introduction to nanotechnology, Nano devices, Nano materials, Nano characterization, Definition of Technology node, Basic CMOS Process flow, meso structures.
Basics of Quantum Mechanics: Schrodinger equation, Density of States, Particle in a box Concepts, Degeneracy, Band Theory of Solids, Kronig-Penny Model. Brillouin Zones

Unit 2: MOS Scaling theory 5 Hours
Shrink-down approaches: Introduction, CMOS Scaling, the nanoscale MOSFET, limits to scaling, system integration limits (interconnect issues etc.)

Unit 3: Nano electronics Semiconductor devices **9 Hours**

Metal-Insulator, Metal-Semiconductor, Metal-Insulator-Metal junctions, Applications of tunnelling: Gate oxide tunneling, Fowler-Nordheim tunneling, Double barrier tunneling Resonant Tunneling Diode, Quantum dots, Coulomb blockade, Single electron transistors, Applications of single electron transistors, Graphene as nanomaterial, Carbon nanotubes, types of carbon nanotubes, Carbon nanotube transistors, Molecular SET's.

Unit 4: MOSFET as Nano device **7 Hours**

Need of finFET's, Vertical transistors, 3D Fin FET structure and its working, finFET's scaling parameters, Surround gate FET, finFET based Inverter, SRAM. Comparison of finFET and planar MOSFET

Unit 5: Characterization techniques for Nano materials: **7 Hours**

FTIR, XRD, AFM, SEM, TEM, EDAX Applications and interpretation of results, Emerging nano materials, nano tubes, Nano rods and other Nano structures, LB technique, soft lithography Microwave assisted synthesis, Self-assembly.

Text/Reference Books:

1. G. W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH,2003.
3. K. E. Drexler, Nano systems, Wiley,1992.
4. J. H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press,1998.

2311378PE302B	Digital Image Processing	04 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.
CO4: Interpret image segmentation and representation techniques.

Unit 1: Introduction **7 Hours**

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 **7 Hours**

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 **7 Hours**

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 **7 Hours**

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 **7 Hours**

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.

2311378PE302C	Introduction to VLSI lifecycle	04 Credits

Course Objectives:

1. To understand VLSI fundamentals: Gain a solid grasp of VLSI technology, semiconductor materials, and the basics of transistor operation.

2. To Learn about the various stages of the VLSI design lifecycle, including specification, design, verification, synthesis, layout, and fabrication.
3. To Explore design methodologies: Introduce different VLSI design methodologies.

Course Outcomes:

1. At the end of this course students will demonstrate the ability to
2. Understand the intricacies in VLSI Design flow
3. Understand overall process of VLSI Design flow starting from system level all the way to the transistor level.

UNIT – 1

System & Architectural Design: Defining a system specification, performance analysis, cost analysis, identifying various functional blocks/modules; categorizing them in terms of digital, analog, RF and mixed signal blocks.

UNIT – 2

Functional verification, logic design: Verifying the functionality of blocks, behavioural description, logic minimization, synthesis, verification and testing

UNIT – 3

Circuit Optimization and Physical Design: Optimization of synthesized blocks for various performance metric, Introduction to placement and route, Layout Vs Schematic (LVS) verification, Design for Manufacturability

UNIT – 4

Tape Out: Post layout simulations, Process Voltage Testing, Process Design Kit, Design Rule Check, GDSII Metalorganic CVD (MOCVD), Plasma Enhanced CVD etc

UNIT – 5

Fabrication and Packaging: CMOS process flow, dicing, various types of packaging.

TEXT/REFERENCE BOOKS

1. Sneh Saurabh, “Introduction to VLSI Design flow”, Cambridge University Press.
2. N. H. E. Weste and C. Harris, “Principles of CMOS VLSI Design: A System Perspective,
3rd Edition, Pearson Education 2007
3. M.Morris Mano and Michel.D.Ciletti, Digital Design with an introduction to HDL, VHDL
and Verilog, Sixth edition Pearson education

2311378PE304A	Microelectronics	04 Credits

Course Objectives:

1. To understand the operation of the various bias circuits of MOSFET and Analyze and design MOSFET bias circuits.
2. To understand the operation and design of multistage amplifier for a given specification.
3. To understand the operation and design of transformer coupled various types of power amplifier circuits.
4. To understand the effects of negative feedback on amplifier circuits.
5. To analyze the different RC and LC oscillator circuits to determine the frequency of oscillation.

Course Outcome:

After successful completion of the course student will be able to:

CO1: Design and analyse the basic operations of MOSFET.

CO2: Know about the multistage amplifier using BJT and FET in various configuration to determine frequency response and concept of voltage gain.

CO3: Know about different power amplifier circuits, their design and use in electronics and communication circuits.

CO4: Know the concept of feedback amplifier and their characteristics.

CO5: Design the different oscillator circuits for various frequencies

Unit 1: MOSFET Review **7 Hours**

MOSFET - Symbol, Types of MOSFET - Depletion and Enhancement type MOSFET (N channel and P channel), Construction, Operation, and V-I characteristics of MOSFET
MOSFET biasing - Types of Depletion & enhancement MOSFET biasing, MOSFET as amplifier.

Unit 2: Multistage Amplifiers **7 Hours**

RC coupled, transformer coupled, direct coupled, Low and high frequency considerations of cascade amplifier, cascode amplifier (CE-CB), Darlington pair amplifier.
Design of Multistage amplifiers Analysis and design considerations of multistage amplifiers (CE-CE, CS-CS, CS-CE,), effect of source and load resistance

Unit 3: Large Signal Amplifiers **7 Hours**

Harmonic distortion and power efficiency of Class A, B, AB, and C amplifiers
Design of Class A, Class B, and Push-Pull Power amplifier design. Thermal considerations and design selection of heat sinks.

Unit 4: Feedback Amplifiers **7 Hours**

Feedback concept, ideal feedback amplifier, classification of
feedbacks, Various topologies Analysis and design of different types of negative feedback.

Unit 5: Oscillators **7 Hours**

Principle of oscillation, RC oscillator, twin T oscillator, Oscillator with LC feedback. Colpitts oscillator, Hartley oscillator, Crystal controlled oscillator. Design of different oscillator circuits.

Text/Reference Books:

1. A. Neamen, "Electronic Circuit Analysis and Design," Tata McGraw Hill, 2nd Edition.
2. R. L. Boylestad, "Electronic Devices and Circuit Theory," Pearson, 11th Edition.
3. T. F. Bogart, "Electronic Devices and Circuit," Merrill, 6th Edition.
4. R. S. Dudhe and M. Farhan, "Electronic Devices and Circuits," Synergy Knowledgeware,1st Edition
5. Salivahanan, N. Suresh Kumar, "Electronic Devices and Circuits," Tata McGraw Hill, 3rd Edition
6. J. Millman, Christos CHalkias, and Satyabratatajit, Millman's, "Electronic Devices and Circuits," McGraw-Hill, 3rd Edition

2311378PE304B Low Power VLSI Circuits & Systems 04 Credits

Course Objectives:

1. To study various low power VLSI circuits & systems
2. To design various low power VLSI circuits & systems

Course Outcome:
After successful completion of the course student will be able to:

CO1: Understand static and dynamic power dissipation in VLSI systems
CO2: Understand Power management in VLSI circuits
CO3: Apply Switched Capacitance Minimization Approaches to reduce power consumption
CO4: Learn leakage power minimization approach
CO5: Learn CAD tools for low power synthesis

Unit 1: Basic of MOS circuits **7 Hours**

MOS Transistor structure and device modelling, MOS Inverters, MOS Combinational Circuits - Different Logic Families.

Unit 2: Sources of Power dissipation **7 Hours**

Dynamic Power Dissipation, Short Circuit Power, Switching Power, Glitching Power Static Power Dissipation, Degrees of Freedom.

Unit 3: Supply Voltage Scaling Approaches **7 Hours**

Device feature size scaling, Multi-Vdd Circuits, Architectural level approaches: Parallelism, Pipelining, Voltage scaling using high-level transformations Dynamic voltage scaling, Power Management.

Unit 4: Switched Capacitance Minimization Approaches **7 Hours**

Hardware Software Trade-off, Bus Encoding, Two's complement Vs Sign Magnitude Architectural optimization, Clock Gating, Logic styles.

Unit 5: Leakage Power minimization Approaches & circuits **7 Hours**

Variable-threshold-voltage CMOS (VTCMOS) approach, multi-threshold-voltage CMOS (MTCMOS) approach, Power gating Transistor stacking, Dual-Vt assignment approach (DTCMOS).

Special circuits: Adiabatic Switching Circuits, Battery-aware Synthesis, Variation tolerant design, CAD tools for low power synthesis

Text/Reference Books:

1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill.
2. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint).
3. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995.
4. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995.

2311378PE304C	Wireless Sensor Networks	04 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.

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. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks Theory and Practice," By John Wiley & Sons Publications, 2011.
2. Sabrie Soloman, "Sensors Handbook" by McGraw Hill publication. 2009
3. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks," Elsevier Publications, 2004
4. Kazem Sohrby, 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.

2311378SE304	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:

Narrativization, 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

1.	Basic Concepts of Film & Video Editing	Saikat Sekhareswar Ray	Satyajit Ray Film & Television Institute

FINAL YEAR
SEMESTER VII

2311378PC313	Analog CMOS VLSI Design	03 Credits

Course Objectives:

1. Understanding of MOS transistor circuits like active load common gate, common source & common drain amplifiers with their frequency response.
2. Understanding of Operational Amplifier Design & Trade-offs.
3. To learn advanced Op-Amps and OTAs.
4. To understand temperature Compensated Biasing Schemes.

Course Outcomes:

After successful completion of the course, student will be able to:

CO1: Recognize trade-offs involved in analog VLSI Circuits
CO2: Analyze current mirrors and bandgap references
CO3: Analyze single stage amplifier using small signal model as well as large signal methodology
CO4: Analyze MOSFET based differential and operational amplifier

Unit 1: CMOS Analog building blocks **6 Hours**

Necessity of CMOS analog design, MOS Models: Structure of MOSFET, Review of characteristics of MOS device, Second order effects, Short Channel Effects, MOS small signal model, MOS spice models.

Unit 2: Current Mirrors and Bandgap References **6 Hours**

Passive and Active Current Mirrors: Basic current mirrors, Cascode current mirrors and Active current mirrors, Band Gap References: General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing.

Unit 3: Single Stage amplifiers **6 Hours**

Basic concepts, Common source stage: resistive load, diode-connected load, current-source load, triode load and source degeneration, Source follower, Common gate stage, Cascode stage.

Unit 4: MOS Operational Amplifiers **6 Hours**

Op-amp: General Considerations, performance parameters, One-stage op-amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations, Slew Rate, Power supply rejection.
Stability and Frequency Compensation: General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps.

Unit 5: Operational Transconductance Amplifiers (OTA) 6 Hours
Design of classical Op-Amps, Wide band Op-Amps, High Speed Op-Amps, Very High Gain Op-Amps, Operational Transconductance Amplifiers, Ultra Low Power OTAs for Medical Implants.

Text/Reference Books:

1. B Razavi, "Design of Analog CMOS Integrated Circuits," 1st Edition, Tata McGraw Hill
2. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design," 3rd Edition, Oxford University Press

2311378PC313L	Analog CMOS VLSI Design Lab	01 Credits

2311378PC315	VLSI Circuits	03 Credits

Course Objectives:

1. To learn Verilog modelling of Combinational and sequential circuits
2. To understand RTL coding
3. To learn design flow of VLSI circuits
4. To use synthesis tools and do simulation of various digital systems

Course Outcomes:
After the successful completion of this course, Students will be able to:

CO1: To design Arithmetic circuits using synthesis tools
CO2: To design memory circuits RAM/ROM
CO3: To study various system design examples
CO4: To understand to use the FPGA board for system design

Unit 1: Review of combinational & sequential circuits 6 Hours
Components of Combinational Design - Multiplexer and Decoder, Multiplexer Based Design of Combinational Circuits, Implementation of Full Adder using Multiplexer Decoder Implementation of Full Adder using Decoder.
PAL - Programmable Array Logic, Comparison of PROM, PLA and PAL, Implementation of a Function using PAL, Types of PAL Outputs Device Examples
Introduction to Sequential Circuits, R-S Latch and Clocked R-S Latch, D Flip Flop, J-K Flip Flop, Master Slave Operation, Edge Triggered Operation

Unit 2: System Design using ASM chart **6 Hours**

Design of Bus Arbiter, ASM Chart State Table, Implementation of Bus Arbiter using MUX and D Flip-flops, Specification of a Traffic Light Controller, State Graph
ASM Chart of Traffic Light Controller.
System Design using sequential circuits: Algorithm of Traffic Light Controller ASM Table Hardware Realization using MUX and D Flip-flops, Traffic Light Controller – ROM Realization - ROM Table.

Unit 3: Design of Memories **6 Hours**

ROM: On-chip Dual Address ROM Design, Test Bench for Dual Address ROM Design Simulation Results, Synplify and Place & Route Results, On-chip Single Address ROM Design, Test Bench for Single Address ROM Design, Simulation Results, Synplify and Place & Route Results.
RAM: Design of On-chip Dual RAM, RTL Verilog Code, Test Bench for Dual RAM Design Simulation Results, Synplify and Xilinx Place & Route Results.

Unit 4: Design of Arithmetic circuits **6 Hours**

Design of Eight Inputs Signed Parallel Adder, Design Partition, Verilog Code for the Signed Parallel Adder, Test Bench for Parallel Adder, Simulation Waveform Synplify and Xilinx Place & Route Results, Parallel, Pipelined Multiplier Design – A new Algorithm for Fast Implementation, Verilog Code for the Parallel, Pipelined Multiplier. Verilog Code for Parallel Multiplier (Continued), Test Bench for Parallel Multiplier, Simulation Results of Back Annotated Parallel Multiplier Design, Synplify and Xilinx Place & Route Results.

Unit 5: System design using FPGA **6 Hours**

Design Applications using FPGA Board, - Traffic Light Controller and Real Time Clock
XSV FPGA Board Features, Testing of FPGA Board, Setting the XSV Board Clock Oscillator Frequency, Downloading Configuration Bit Streams. Real Time Clock Design Features and Specification, Block Diagram and Signal Descriptions of Real Time Clock Simplified Architecture of Real Time Clock, Verilog RTL Code for Real Time Clock

Text/ Reference Books:

1. J. M. William, “Digital VLSI Design with Verilog,” Springer International Publishing, 2014
2. S. M. Kang, Y. Leblebici, “CMOS Digital Integrated Circuits,” Tata-McGraw Hill 3rd edition, 2002
3. S. Palnitkar, “Verilog HDL: A guide to digital design & synthesis,” Pearson, 2nd edition, 2003

2311378PE403A	Biomedical Electronics	03 Credits

Course Objectives:

1 Have a basic understanding of medical terminology, relevant for biomedical instrumentation.
2 Explain and describe different diagnostic measurement methods for different human variables and their necessary instrumentation.
3 Explain and describe different therapeutic methods of treatment where electrical medical equipment is a vital part of the method and their necessary instrumentation.
4 Explain and describe different diagnostic measurement methods for identification of humane bio-potentials and their necessary instrumentation.
5 Understand and describe the physical and medical principles used as a basis for biomedical instrumentation.
6 Understand the elements of risk for different instrumentation methods and basic electrical safety.
7 Understand the position of biomedical instrumentation in modern hospital care.

Course Outcomes:

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: 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 7 Hours

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

Unit 2: Central Nervous and Cardio-Vascular System 7 Hours

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 7 Hours

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 **7 Hours**

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 **7 Hours**

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 **7 Hours**

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

Text/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.

2311378PC403B	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:

After successfully completing the course students will be able to:

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 **7 Hours**

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 **7 Hours**

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, Gigabit Ethernet, 10 Gigabit Ethernet.

Unit 3: Wireless LANS & Virtual Circuit Networks and Network Layer **7 Hours**

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 **7 Hours**

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 **7 Hours**

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, Tata McGraw-Hill.
3. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.
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.

2311378PC403C	VLSI Design Flow: RTL to GDS	03 Credits

Course Objectives:

The course develops skills to use design automation tools for chip designing.

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

CO1: Understand RTL to GDS VLSI design flow
CO2: Understand RTL synthesis
CO3: Learn Static timing analysis
CO4: Understand chip planning
CO5: Understand Clock Tree Synthesis

Unit 1: Overview of VLSI design Flow & RTL Synthesis **7 Hours**
RTL to GDS Implementation: Logic Synthesis, Physical Design; Verification and Testing; Post GDS Processes

RTL Synthesis: Verilog Constructs to Hardware Logic Optimization: Definitions, Two-level logic optimization

Unit 2: Static Timing Analysis (STA) **7 Hours**
Synchronous Behaviour, Timing Requirements, Timing Graph, Mechanism, Delay Calculation, Graph based Analysis, Path-based Analysis, Accounting for Variations, Constraints: Clock, I/O, Timing Exceptions Technology Mapping Timing-driven Optimizations. Power Analysis, Power-driven Optimizations Design for Test: Basics and Fault Models, Scan Design Methodology.

Unit 3: Design for Test **7 Hours**
ATPG, BIST Basic Concepts for Physical Design: IC Fabrication, FEOL, BEOL, Interconnects and Parasitic, Signal Integrity, Antenna Effect, LEF files

Unit 4: Chip Planning **7 Hours**
Partitioning, Floorplanning, Power Planning Placement: Global Placement, Wirelength Estimates, Legalization, Detailed Placement, Timing-driven Placement, Scan Cell Reordering, Spare Cell Placement.

Unit 5: Clock Tree Synthesis **7 Hours**
Terminologies, Clock Distribution Networks, Clock Network Architectures, Useful Skews Routing: Global and Detailed, Optimizations Physical Verification: Extraction, LVS, ERC, DRC, ECO and Sign-off.

Textbook & References:

1. S. Palnitkar, “Verilog HDL: A guide to digital design & synthesis,” Pearson, 2nd edition, 2003

2311378PE405A	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 **7 Hours**

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 magnetic field. Virtual height, MUF, Skip distance. Ionospheric abnormalities. Multi-hop propagation. Space link geometry. Characteristics of Wireless Channel: Fading, Multipath delay spread, Coherence Bandwidth, and Coherence Time.

Unit 2: Antenna Fundamentals and Wire Antennas **7 Hours**

Introduction, Types of Antennas, 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 **7 Hours**

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 Dolph Chebyshev array. Planar Array, Circular Array, Log Periodic Antenna, Yagi Uda Antenna Array.

Unit 4: Concepts of Smart Antennas **7 Hours**

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 **7 Hours**

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", Satya Prakashan, New Delhi.
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.

2311378PE405B Neural Networks & Fuzzy Logic 03 Credits

Course Objectives:

1. To study basics of biological Neural Network.
2. To understand the different types of Artificial Neural Networks.
3. To identify the applications of ANN.
4. To study fuzzy logic and fuzzy systems

Course Outcomes:

After successful completion of the course students will be able to:

CO1: Understand learning rules of ANN.
CO2: Apply the concepts of supervised and unsupervised neural networks
CO3: Explain the importance of feedback networks
CO4: Understand Associative memory networks
CO5: Appreciate the need for fuzzy logic and control
CO6: Illustrate neural networks practical applications

Unit 1: Introduction **7 Hours**

Biological neurons, McCulloch -Pitts neuron model, Types of activation function, Network architectures, Knowledge representation. Linear & non-linear separable classes & Pattern classes. Learning processes: Supervised learning, Unsupervised learning, and Reinforcement learning Learning Rules: Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner Take-All

Learning Rule.
Applications and scope of Neural Networks.

Unit 2: Supervised Learning Networks **7 Hours**

Perception Networks – continuous & discrete, Perceptron convergence theorem, Adaline, Madaline, Method of steepest descent and least mean square algorithm. Back Propagation Network. Radial Basis Function Network.

Unit 3: Unsupervised Learning Networks **7 Hours**

Fixed weights competitive nets. Kohonen Self-organizing Feature Maps, Learning Vector Quantization. Adaptive Resonance Theory – 1.

Unit 4: Associative Memory Networks **7 Hours**

Introduction, Training algorithms for Pattern Association, Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory.

Unit 5: Fuzzy Logic & Case studies on ANN **7 Hours**

Fuzzy Sets, Fuzzy Relations and Tolerance and Equivalence. Fuzzification and Defuzzification, Fuzzy Controllers.
Handwritten Digit Recognition, Process Identification, Expert Systems for Low Back Pain Diagnosis.

Text/Reference Books:

1. Jacek M. Zurada, "Introduction to Artificial Neural Systems," Jaico Publishing House.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," 3rd edition, Wiley India.
3. S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing," 3rd edition, Wiley India.
4. Simon Haykin, "Neural Networks a Comprehensive Foundation," 3rd edition Pearson Education.
5. S Rajasekaran and G A Vijayalakshmi Pai, "Neural Networks and Fuzzy Logic and Genetic Algorithms ", PHI Learning.

2311378PE405C	Information Theory & Coding	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: Theory of Probability and Random Processes 7 Hours

Concept of probability, random variables, random process, power spectral density of a random process, probability models, statistical averages, central limit theorem, correlation, linear mean square estimation.

Unit 2: Noise in Communication Systems 7 Hours

Behavior of analog and digital communication systems in the presence of noise, Sources of noise, Noise representation, Noise filtering, Noise bandwidth, Performance of analog and digital communication systems in the presence of noise.

Unit 3: Information Theory 7 Hours

Measure of information, Joint entropy and conditional entropy, Relative entropy and mutual information, Markov sources, Source encoding, Shannon-Fano coding and Huffman coding, Shannon's first and second fundamental theorems, Channel capacity theorem.

Unit 4: Error Correcting Codes and Markov sources 7 Hours

Galois fields, Vector spaces and matrices, Block codes, Cyclic codes, Burst-error detecting and correcting codes, Multiple error correcting codes, Convolutional codes, ARQ Markov sources: Shannon's noisy coding theorem and converse for discrete channels; Calculation of channel capacity and bounds for discrete channels; Application to continuous channels

Unit 5: Speech Coding 7 Hours

Characteristics of speech signal, Quantization techniques, Frequency domain coding, Vocoders, Linear predictive coders, Codecs for mobile communication, GSM codec, USDC codec, Performance evaluation of speech coders.

Text/Reference Books:

1. B. P. Lathi; Modern Digital and Analog Communication Systems; Oxford Publication.
2. Das, Mullick, Chatterjee; Principles of Digital Communication; New Age International.
3. Taub, Schilling, Principles of Communication Engineering (2^{nd} Edition), TMH.
4. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory, Wiley Interscience.
5. R.P.Singh, S.D. Sapre; Communication systems: Analog and Digital; TMH.
6. Theodore S. Rappaport; Wireless Communication: Principles and Practice (2^{nd} Edition), Pearson India.

7. N. Abramson, Information and Coding, McGraw Hill,1963.

2311378RM401	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:

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

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 1 **7 Hours**

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 2 **7 Hours**

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

Unit 3 **7 Hours**

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

Unit 4 **7 Hours**

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

Unit 5 **7 Hours**

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

2311378PC312	CMOS Digital VLSI Design	03 Credits

Course Objectives:

1. Basic device understanding and then dealing with complex digital circuits keeping in mind the current trend in technology.
2. Learning design perspective, starts from basic specifications and ends with system level blocks.

Course Outcomes (CO):

After successful completion of the course, student will be able to:

CO1: Explain scaling theory for MOSFET
CO2: Design MOSFET based inverter circuits with given constraints
CO3: Analyze MOSFET based combinational and sequential logic circuits
CO4: Realize MOSFET based logic circuits with different design styles
CO5: Explain principle of working of semiconductor memories

Unit 1: Review of MOSFET Physics **6 Hours**

Threshold Voltage Equation, MOSFET Structure and Operation, Current-Voltage Characteristics and MOSFET Capacitances, MOSFET Scaling, Types of scaling and small geometry effects.

Unit 2: MOSFET inverters **6 Hours**

Static Characteristics of resistive load and CMOS Inverter, comparison of all types of MOS inverters, Dynamic Characteristics of inverters, design of CMOS inverters with constraints.

Unit 3: Combinational circuit design using various CMOS design styles **6 Hours**

MOS Logic Circuits with Depletion NMOS Loads and CMOS Logic Circuits, Complex Logic Circuits and Concept of equivalent CMOS inverter.

Dynamic logic, Domino, Dual Rail Domino logic, Pseudo NMOS, NORA, Zipper, C^2MOS, Pass transistor logic, transmission gate.

Implementation of multiplexer, decoder, comparator, Binary to Gray code converters, demultiplexer, encoder using various dynamic logic design style.

Unit 4: Sequential MOS logic circuits **6 Hours**

Circuit Realization: SR Latch, JK latch, D latch, SR FF, JK FF, D FF, 1 Bit Shift Register.

Unit 5: Semiconductor memories **6 Hours**

ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits), DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits), Flash (mechanism, NOR flash, NAND flash) Peripheral Circuits: Sense amplifier, decoder.

Text/Reference Books:

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design," Third Edition, Tata McGraw-Hill.
2. J. M. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective" Second Edition, Pearson Education.

2311378PE406A Data Structure & Algorithms Using Java Programming 02 Credit

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 Queues: 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 complexity analysis.

Text/Reference Books:

1. Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
2. "How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.
3. Ellis Horowitz, Sartaj Sahni, "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.

2311378PE406B	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.

Week 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

Week 2: 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.

Week 3: 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.

Week 4: 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.

Week 5: 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.

Week 6: 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.

Week 7: 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.

Week 8: 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.

2311378PE406C SOC Desing: Design & Verification 02 Credits

Course Outcomes:

1. Understand and apply the complete SoC chip design flow, from conception to implementation.
2. Master Verilog as a language for RTL design
3. Integrate digital and analog IPs into a cohesive SoC design
4. Use simulation techniques for thorough RTL verification.

Unit 1 Introduction to SoC Chip Design Flow

Overview of the complete SoC chip design flow. Introduction to EDA tools: Synopsys, Cadence, Siemens, and open-source alternatives.

Unit 2: Verilog-Based RTL Design

Verilog-Based RTL Design , In-depth study of Verilog syntax and constructs. Verilog-based digital system design.

Unit 3 Integration of Digital and Analog IPs in SoC Design

Understanding digital and analog IPs. Techniques for integrating diverse IPs into a single SoC.

Unit 4: RTL Verification

Simulation-based verification techniques. RTL Verification using Formal Methods Introduction to formal verification. Application of formal methods in RTL verification.

Unit 5: Scripting Languages for Chip Design Automation

Introduction to scripting languages (TCL and Perl). Development of automation scripts for design tasks. Rapid prototyping using FPGAs. Validation of designs using emulation hardware.

Recommended Books

1. Cem Unsalan, Bora Tar. Digital System Design with FPGA: Implementation using Verilog and
VHDL. McGrawHill, First Edition.
2. Nekoogar, Farzad. From ASICs to SOCs. Prentice Hall Professional, 2003.
3. Wolf, Wayne. Modern VLSI Design. Pearson Education, 2002.

4. Chakravarthi, Veena. A Practical Approach to VLSI System on Chip (SoC) Design. Springer
Nature, 2019.