PONDICHERRY UNIVERSITY

PUDUCHERRY

ACADEMIC CURRICULUM

(REGULATIONS)

FOR

BACHELOR OF VOCATIONAL DEGREE

CHOICE BASED CREDIT SYSTEM

B.Voc. – APPLIED ELECTRONICS AND CHIP DESIGN

(Applicable to the students admitted from the Academic Year 2023-24 onwards)

CONTENTS

1. Introduction

1. 1.About B.Voc

Realizing the importance and the necessity for developing skills among students, and creating work ready manpower on large scale especially to meet the demand-supply mismatch in the Indian Economy, the University Grants Commission (UGC), Ministry of HRD, Government of India had launched a scheme on 27 February, 2014 for skills development based higher education as part of college/university education, leading to Bachelor of Vocation (B.Voc.). In these courses, the institute will conduct general education content and sector-specific skills will be imparted by Skill Knowledge Providers/ Training Providers/ Industries.

2. Key Features:

Objectives

- To ensure integral development of skills, competencies, and inner capacities. Specifically, skills related to their program, competencies to use skills to create empowering cultures at home and work, and to know their inner capacity of the values they stand for in life.
- To ensure that the students are adequately developed at each exit point of the program.
- To provide flexibility to the students by means of pre-defined entry and multiple exit points.
- To address the National Skills Qualifications Framework (NSQF) within the undergraduate level of higher education by developing the five minds of the future to enhance the impact of the students when they are engaged in an industry or when they create their own enterprise.
- To provide vertical mobility to students admitted in such vocational courses through certification levels will lead to Diploma/Advanced Diploma/B. Voc. Degree in Applied Electronics and Chip Design and will be offered by Pondicherry University.
- Students may be awarded Level Certificate/Diploma/Advanced Diploma /Degree as out-lined in the Table:

Award	Course	Duration after class XII or equivalent	Corresponding NSQF level
Level 4 Certificate	Certificate	06 Months (30 Credits)	**4**
Level 5 Certificate	Diploma	1 Year (60 Credits)	**5**
Level 6 Certificate	Advance Diploma	2 Year (120 Credits)	**6**
Level 7 Certificate	**B.Voc Degree**	**3 Year (180 Credits)**	**7**

3. Course Objectives

The course aims to develop the integral personality of an individual as needed at the highest level of NSQF in stages. After completing the vocational course, the student would not only have acquired relevant appropriate and adequate technical knowledge to work in high-end jobs like chip design and layout, but also have competencies not just to take up gainful employment, but to create a healthy environment in the workplace and some will even be able to start their enterprise.

A. Understanding of

(a) The relevant basic concepts and principles in basic science subjects (Physics and Mathematics) so that he/she can understand the different vocational subjects.

(b) The basic concepts in drawing circuits and layouts.

(c) The concepts, and principles of different devices and circuits.

(d) The concepts of analog and digital layout and circuits

(e) Understanding of the fabrication process

B. Adequate Professional Skills and Competencies in

(a) Selecting the raw material for the required Production according to the end product.

(b) Developing the devices required for mass production.

(c) Preparing the production layout according to the procedures involved in manufacturing.

(d) Locating the fault at the production level due to improper process, scheduling etc. and its rectification.

C. A Healthy and Professional Attitude so that He/ She has

(a) An analytical approach while working on a job.

(b) An open mind while locating/rectifying faults.

(c) Respect for working with his/her own hands.

(d) Respect for honesty, punctuality and truthfulness.

D. NSQF compliant skills in Qualification developed by sector skill council in Capital Goods Sector.

4. Course Structure

The course will consist of a combination of theory, practice,hands-on skills and integral development of the personality. The curriculum of the past where there are separate theories and practical is replaced by immediate application to build the disciplined mind. Each item needs to be understood, practiced, remembered for this. Further, there is a need to synthesize so that the learning can be increased and

does not get lost as the students continue to grow their skills and knowledge. In addition, the development of leadership and agency in students will help the program be effective.

Skill Development Components:

- The focus of skill development components shall be to equip students with appropriate knowledge, practice and attitude, to become work-ready. The skill development components will be relevant to the industry as per its requirements.
- The overall design of the skill development component along with the job roles selected will be such that it leads to a comprehensive specialization in few domains.
- The curriculum will focus on work-readiness skills in each of the year of training.
- Adequate attention will be given in curriculum design to practical work, on the job training, development of student portfolios and project work.

General Education Component:

- The general education component adheres to the normal senior secondary and university standards. It will emphasize and offer courses that provide holistic development. However, it will not exceed 40% of the total curriculum.
- Adequate emphasis is given to language and communication skills.

The curriculum should be designed in a manner that at the end of year-1, year-2 and year-3, students are able to meet below mentioned level descriptors for level 5, 6 and 7 of NSQF, respectively which are as given below:

Level	Process required	Professional Knowledge	Professional skill	Core skill	Responsibility
Level 5	Job that requires well developed skill, with clear choice of procedures in familiar context	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools materials and information	Desired mathematical skill, understanding of social, political and some skill of collecting and organizing information, communication.	Responsibility for own work and learning and some responsibility for other's works and learning

Level 6	Demands wide range of specialized technical skill, clarity of knowledge and practice in broad range of activity involving standard/ non-standard practices	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Reasonably good in mathematical calculation, understanding of social, political and reasonably goodin data collecting organizing information, and logical communication	Responsibility for own work and learning and full responsibility for other's works and learning
Level 7	**Requires a command of wide ranging specialized theoretical and practical skill, involving variable routine and non- routine context**	**Wide ranging, factual and theoretical knowledge in broad contexts within a field of work or study**	**Wide range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study**	**Good logical and mathematical skill understanding of social political and natural environment good in collecting and organizing information, communication and presentation skill**	**Full responsibility for output of group and development**

Eligibility for Admission:

Candidates for admission to B.Voc (Applied Electronics and Chip Design) shall be required to have passed 10+2 or 10+ITI (2 years) or its equivalent from a recognized board of examination. With a minimum of 50%.

Medium:

The medium of instruction shall primarily be English.

ELIGIBILITY FOR APPEARING FOR SEMESTER EXAMINATION:

Although having 100% overall attendance in all of the courses throughout a semester is desirable, a student must have at least 75% overall attendance in order to be eligible to take the exam. A student who has an overall attendance rate of less than 75% but a semester attendance rate of 60% or above may only be authorised to present for the semester examination on medical grounds after submitting the required condonation fee and a medical certificate issued by a medical officer.

If a student's overall attendance for a semester is less than 60%, they are not allowed to take the semester exam and therefore cannot continue to the next semester.

5. Assessment

a.Theory Courses

All theory courses shall be assessed as follows:

Assessment Method	Marks
Continuous Assessment (Internal)	40
Semester Examination (External)	60
Total	100

Continuous Assessment (Internal)

Continuous Assessment (Internal)	Marks
Attendance	05
Internal Assessment Test	25
Assignments	10
Total	40

Attendance carries 5 marks (5 marks for 100% to 95% attendance, 4 marks for 94% to 90% attendance, 3 marks for 89% to 85% attendance, 2 marks for 84% to 80% attendance and 1 mark for 79% to 75% attendance), cycle test carries 25 marks. Performance in the best two of the three tests will be taken for assessment. Assignments carrying 10 marks, shall be in the form of problems, small projects, quizzes, design problems, etc., depending upon the subject content.

Semester Examination

The pattern of Semester Examinationquestion papers for theory courses is as follows:

a. The duration of the examination shall be 3 hours with a maximum of 60 marks.

b. Section A contains 5 compulsory questions each carrying 2 marks. Only one question shall be selected from each unit. This section carries 10 marks in total.

c. Section B contains five questions, one question from each unit with *'either' 'or' choice.* Each question carries ten marks. Based on necessity, each question may contain sub-divisions. This section carries 50 marks in total.

b.Practical Courses:

All practical courses shall be assessed as follows:

Assessment Method	Marks
Continuous Assessment	60
Semester Examination	40
Total	100

Continuous Assessment (Internal)

Continuous Assessment (Internal)	Marks
Attendance	05
Model examination	15
Regular Laboratory Work	20
Viva/mini project	20
Total	60

Attendance carries 5 marks (5 marks for 100% to 95% attendance, 4 marks for 94% to 90% attendance, 3 marks 89% to 85% attendance, 2 marks for 84% to 80% attendance and 1 mark for 79% to 75% attendance).The regular performance in the practical class (Observation and Record) will be evaluated for 20 marks. Performance in the Model examination conducted at the end of the semester will be evaluated for 15 marks. The pattern of the Model Examinationwill be similar to the Semester Examination.

Semester Examination

The Semester Examination of the practical courses will be evaluated for 40 marks by a panel of examiners comprising an internal examiner and an external examiner. The Break-up of marks is as follows:

Algorithm/Circuit theory : 10 marks

Practical work, calculations and debug : 20 marksViva-

Voce : 10 marks

c.Project Work

The Project work carried out in the seventh and eighth semesters- shall be assessed as follows:

Assessment Method	**Marks**
Continuous Assessment (Internal Evaluation)	60
Semester Examination (External Evaluation)	40
Total	100

i. Marks allocated for *Continuous Assessment* are distributed as given in the following table.

Assessment Method	**Marks**
Guide	25
Project Evaluation Committee	35
Total	60

The guide shall evaluate the student for 25 marks based on the work carried out.

a. The Project Evaluation Committee comprising the Head of the Department and two other faculty members shall evaluate the project for 35 marks. The evaluation will be carried out through three reviews. The Project Evaluation Committee is constituted by the Head of the Department.

ii. The final *Semester Examination* of the Project Work will be conducted by a panel of examiners comprising an internal examiner and an external examiner. The Break-up of marks is as follows:

Project report	: 15 marks
Presentation	: 15 marks
Viva-Voce	: 10 marks

d. Theory cum Practice Courses

All theory cum practice courses shall be assessed as follows:

Assessment Method	Marks
Continuous Assessment (Internal)	40
Semester Examination (External)	60
Total	100

Continuous Assessment (Internal)

Continuous Assessment (Internal)	Marks
Attendance	05
Internal Assessment (Cycle Test + Model Exam)	20
Regular Laboratory work	15
Total	40

Attendance carries 5 marks (5 marks for 100% to 95% attendance, 4 marks for 94% to 90% attendance, 3 marks for 89% to 85% attendance, 2 marks for 84% to 80% attendance, and 1 mark for 79% to 75% attendance), Internal Assessment test comprises of cycle test carries 10 marks (Performance in the best two of the three tests will be taken for assessment) and the model examination conducted at the end of the semester which carries 10 Marks, and regular performance in the practical class (Observation and Record) will be evaluated 15 marks.

Semester Examination

The *Semester Examination* will be conducted as Semester Examination theory and semester Examination Practical each carrying 30 Marks.

The pattern of Semester Examination question papers for theory courses is as follows:

a. The duration of the examination shall be 2 hours with a maximum of 30 marks.
b. Section A contains five questions, one question from each unit with *'either' 'or' choice.* Each question carries six marks. Based on necessity, each question may contain sub-divisions.

The Semester Examination of the practical courses will be evaluated for 30 marks by a panel of examiners comprising an internal examiner and an external examiner. The Break-up of marks is as follows:

Procedure	: 10 marks
Practical work and calculations	: 15 marks
Viva-Voce	: 05 marks

E.On-Job Training

Depending on the job role (Qualification Packs) that the students have chosen in the industries, the assessment for on-the-job training will be carried out in accordance with the relevant Skill Sector Council.

f. Declaration of Results

Examination Passing Criteria:

i) A student is declared to have ***passed*** a course if he gets 40% marks and above in the Semester Examination and 50% marks and above overall (Semester Exam marks and Continuous Assessment marks put together).

ii) If a student fails to clear the semester examination of a theory course after three consecutive attempts, the passing criteria from the fourth attempt onwards will be based on the marks earned by the student in the end-semester examination only. The student is deemed to have passed the course if the mark scored in the end semester examination is 50% and above and he will be awarded only a **C grade** irrespective of the mark scored.

g. Award of grades

The performance of students in a course is expressed in terms of Letter Grades, each carrying certain Grade Points. A total of Six passing Grades namely O, A+, A, B+, B, and C is awarded. Total marks (s*um of Continuous Assessment and Semester Examination marks*) secured by a student in a course are used for computing his Grade by fitting the mark into the Range of Marks assigned for each Grade shown in the table below.

Range of Marks	Letter Grade	Grade Points
91 to 100	O	10
81 to 90	A+	9
71 to 80	A	8
61 to 70	B+	7
56 to 60	B	6
50 to 55	C	5
0 to 49	F	0
Absent	FA	0

a. A student who has secured an 'F' and 'FA' grade shall reappear for the examination in the following semesters. A student who has scored a passing grade other than an "F" and "FA" cannot reappear for the examination.

b. A student securing an 'F' grade in an elective course may reappear for the examination in the following semester or drop the elective course and subsequently register for another elective course in the following semester in place of the dropped elective course.

c. *Grade Point Average* (GPA) indicates the performance of a student in all the examinations appeared him in a particular semester. GPA score will appear in all the Semester Examination Grade Cards. The *Grade Point Average* (GPA) for a particular semester is calculated as the ratio of the sum of the products of the number of Credits of a course (C_i) and the Grade Points scored in that course (GP_i), taken for all the courses, to the sum of the number of credits of all the courses (n) registered in that semester.

$$GPA = \frac{\sum^{n} C_i GP_i}{\sum^{n} C_i}$$

where n is the number of courses registered in that semester. For a student who has partially withdrawnfrom writing examinations of courses in a semester, n is counted as the total number of courses that appeared in that semester minus the number of courses partially withdrawn.

d. *Cumulative Grade Point Average* (CGPA) indicates the performance of a student in all the examinations appeared by him up to a particular semester. CGPA score will appear in all the Semester Examination Grade Cards starting from the first semester. The *Cumulative Grade Point Average*

(CGPA) up to a particular semester is calculated as follows:

$$CGPA = \frac{\sum^{n} C_i \, GP_i}{\sum^{n} C_i}$$

where $C_i$is the Credit of a course, $GP_i$is the Grade Point obtained by the student in that course and n is the total number of courses registered up to that semester starting from the first-semester

OJT Rules and Regulations:

OJT model works as the primary value for providing the familiarity of genuine work in a representative situation to the students by the mentor under closed supervision for two months. A prime aspect of the internship/research internship is induction into actual work situations. OJT is providing opportunities to students for active engagement in on-site experiential learning, hands-on training where individuals learn how to perform tasks or duties .while actually doing them, rather than through formal classroom instruction or theoretical learning alone. OJT helps to students develop practical skills and knowledge directly related to their job responsibilities

On-the-job training (OJT) in chip design typically involves gaining practical experience and skills while working directly in a semiconductor company. Learning to use industry-standard software tools for designing integrated circuits (ICs), such as CAD (Computer-Aided Design) tools and simulation software.,Understanding Design Methodologie, Hands-on Project Work**,** Testing and Verification, Documentation and Reporting Collaboration and Communication, Understanding Industry Standards**,** Problem Solving and Troubleshooting**,** Learning from Experienced Engineers, Continuous Learning**: OJT** Develops Students Emphasizing the importance of staying updated with the latest advancements in semiconductor technology and design methodologies. OJT in chip design provides a valuable opportunity to apply theoretical knowledge gained from academic studies to practical, real-world scenarios. It helps in developing a strong foundation in semiconductor design and preparing for a career in the semiconductor industry.

Company Details:

- Intel India
- Texas Instruments India
- Analog Devices India
- NXP Semiconductors India
- Qualcomm India
- Broadcom India
- Cadence Design Systems
- Synopsys India
- Xilinx India

Wipro Ltd

CURRICULUM

Below Table shows for cumulative credits awarded to the learners in skill based vocational courses.

NSQF Level	Skill Component Credits	General Education Credits	Total Credits for Award	Normal Duration	Exit Points/ Awards
4	18	12	30	One Semester	Certificate
5	36	24	60	Two Semesters	Diploma
6	72	48	120	Four Semesters	Advanced Diploma
7	108	72	180	Six Semesters	B.Voc Degree

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NSQF Level 4 SEMESTER - I							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1		Introduction to Programming	VG	4	0	0	4
2		Basic Electronics	VC	4	0	0	4
3		English-I	GSH	3	0	0	3
4		Applied Mathematics	GSH	3	0	0	3
LABORATORY							
5		ESP32 Programming in Python	VG	0	0	6	3
6		Basic Electronics Lab	VC	1	0	6	4
7		PCB Design and EDA Lab	VC	0	0	6	3
8		Essential Science (Theory and practice)	GSH	2	0	2	3
9		Indian culture and universal values (Theory and practice) - I	GSH	1	0	4	3
						TOTAL CREDITS	**30**

NSQF Level 5 SEMESTER - II							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1		Digital Gates and IC Layout	VC	4	0	0	4
2		English - II	GSH	3	0	0	3
3		Applied Mathematics for Electronics - I	GSH	3	0	0	3
LABORATORY							
4		Basic Digital Gates Lab	VC	1	0	4	3
5		IC Layout -- Digital Lab (Theory and practice)	VC	1	0	6	4
6		Integral yoga and value embodied leadership - I	GSH	1	0	4	3
ON-JOB-TRAINING (OJT)							
7		On the Job training	OJT	-	-	10	10
						TOTAL CREDITS	**30**

NSQF Level 6 SEMESTER - III							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1		Basic Circuit Theory	VC	4	0	0	4
2		Digital Logic design	VC	4	0	0	4
3		Applied Physics	VG	3	0	0	3
4		Basic Indian Language (Hindi)	GSH	3	0	0	3
LABORATORY							
5		Circuits &Simulation Lab	VC	1	0	4	3
6		Digital Logic design Lab	VC	0	0	6	3
7		Microcontroller Theory and Lab (Theory and practice)	VG	2	0	4	4
8		Electronic drafting, tracing and debug	GSH	1	0	4	3
9		Integral yoga and value embodied leadership I - Refresher	GSH	1	0	4	3
						TOTAL CREDITS	**30**

NSQF Level 6 SEMESTER - IV							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1		Foreign Language (German/French)	GSH	2	0	0	2
2		Applied Mathematics for Electronics - II	GSH	3	0	0	3
LABORATORY							
3		Basic Analog Circuits – Layout Lab	VC	0	0	6	3
4		Basic Analog Circuits – Modeling Lab	VC	0	0	2	1
5		Basic Analog Circuits – Operation & Layout	VC	2	0	4	4
6		Integral Yoga and Value embodied leadership II	GSH	1	0	4	3
ON-JOB-TRAINING							
7	On the Job Training						10
						TOTAL CREDITS	**30**
	Students need to go On-Job-Training for qualification packs to get 10 credits.						

NSQF Level 7 SEMESTER - V							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1		CMOS Analog IC Design - I	VC	4	0	0	4
2		Basic Control Systems Principles	VG	4	0	0	4
3		Vocational Elective-I	VE	3	0	0	3
4		Vocational Elective – II	VE	3	0	0	3
5		Soft Skill Development - I	GSH	3	0	0	3
LABORATORY							
6		CMOS Analog IC Design – I Lab	VC	2	0	4	4
7		Introduction to Signals and Systems	GSH	1	0	4	3
ON-JOB-TRAINING							
8		Project Phase - I					6
						TOTAL CREDITS	**30**

NSQF Level 7 SEMESTER - VI							
Sl. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**
THEORY							
1		CMOS Analog IC Design - II	VC	4	0	0	4
2		Vocational Elective-III	VE	3	0	0	3
3		Soft Skill Development - II	GSH	1	2	0	3
LABORATORY							
4		IC Layout – System Considerations	VC	2	0	4	4
5		CMOS Analog IC Design – II Lab	VC	0	0	8	4
6		Indian culture and universal values - II	GSH	1	0	4	3
7		Innovative and Design Thinking	GSH	1	0	4	3
ON-JOB-TRAINING							
8		Project Phase - II					6
						TOTAL CREDITS	**30**

Students need to go On-Job-Training for qualification packs to get 6 credits

On the basis of learning in the B.Voc. Programme, i.e. Level 5 to Level 7, a project to be taken up by the student strengthening his/ her vocational skills.

PROGRAMME TOTAL CREDITS = 180

GENERAL SCIENCE AND HUMANITIES (GSH)

Sl. No	Course Code	Subject	Semester	Credits
1		English-I	I	3
2		Applied Mathematics	I	3
3		Essential Science (Theory and practice)	I	3
4		Indian culture and universal values - I	I	3
5		English - II	II	3
6		Applied Mathematics for Electronics - I	II	3
7		Integral yoga and value embodied leadership - I	II	3
8		Basic Indian Language (Hindi)	III	3
9		Electronic Drafting, Tracing and Debug	III	3
10		Integral yoga and value embodied leadership I - Refresher	III	3
11		Foreign Language (German/French)	IV	3
12		Applied Mathematics for Electronics - II	IV	3
13		Integral Yoga and Value embodied leadership II	IV	3
14		Soft Skill Development - I	V	3
15		Introduction to Signals and Systems	V	3
16		Soft Skill Development - II	VI	3
17		Indian culture and universal values - II	VI	3
18		Innovative and Design Thinking	VI	3
		TOTAL CREDITS		**57**

VOCATIONAL GENERAL (VG)

Sl. No	Course Code	Subject	Semester	Credits
1		Introduction to Programming	I	4
2		ESP32 Programming in Python	I	3
3		Applied Physics	III	3
4		Microcontroller Theory and Lab (Theory and Practice)	III	4
5		Basics of Control System Principles	V	4
		TOTAL CREDITS		**18**

VOCATIONAL CORE COURSES (VC)

Sl. No	Course Code	Subject	Semester	Credits
1		Basic Electronics	I	4
2		Basic Electronics Lab	I	4
3		PCB Design and EDA Lab	I	3
4		Digital Gates and IC Layout	II	4
5		Basic Digital Gates Lab	II	3
6		IC Layout -- Digital Lab (Theory and Practice)	II	4
7		Basic Circuit Theory	III	4
8		Digital Logic design	III	4
9		Circuits & Simulation Lab	III	3
10		Digital Logic design Lab	III	3
11		Basic Analog Circuits – Operation & Layout	IV	4
12		Basic Analog Circuits – Layout Lab	IV	3
13		Basic Analog Circuits - Modeling lab	IV	4
14		CMOS Analog IC Design - I	V	4
15		CMOS Analog IC Design – I Lab	V	4
16		CMOS Analog IC Design - II	VI	4
17		IC Layout – System Considerations	VI	4
18		CMOS Analog IC Design – II Lab	VI	4
		TOTAL CREDITS		**68**

VOCATIONAL ELECTIVE COURSES (VE)

Sl. No	Course Code	Subject	Semester	Credits
1		Physics of Semiconductor Devices	V	3
2		Organizational Behavior	V	3
3		Advanced Circuit Modeling	V	3
4		Nanotechnology for Energy systems	V	3
5		Programming For Problem Solving	V	3
6		Product Development	V	3
7		Solar Thermal Technology	V	3
8		Electronic Manufacturing Process	V	3
9		IC Verification – System Verilog	VI	3
10		VHDL Programming	VI	3
11		Electric Vehicles	VI	3
12		Transmission lines	VI	3
13		Project Management	VI	3
		TOTAL CREDITS		**9**

EMPLOYABILITY/ENTREPRENEURSHIP ENHANCEMENT COURSES (EEC)

Sl. No	Course Code	Subject	Semester	Credits
1		Project Phase – I	V	6
2		Project Phase – II	VI	6
		TOTAL CREDITS		**12**

ON JOB TRAINING COURSE (OJT)

Sl. No	Course Code	Subject	Semester	Credits
1		On the Job Training	II	10
2		On the Job Training	IV	10
		TOTAL CREDITS		**20**

CREDIT DISTRIBUTION

SEMESTER	I	II	III	IV	V	VI	CREDIT
General Science and Humanities (GHS)	12	9	9	9	6	9	54
Vocational General (VG)	7		7		4		18
Vocational Core (VC)	11	11	15	11	8	12	67
Vocational Elective (VE)					6	3	9
Employability Enhancement Courses (EEC)					6	6	12
On Job Training Course (OJT)		10		10			20
TOTAL CREDITS	30	30	30	30	30	30	180

NON CGPA COURSES DETAILS

	I	II	III	IV	V	VI	VII
Sports	√	√	√	√	√	√	√
Industry Supported Course	√	√	√	√	√	√	√

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	INTRODUCTION TO PROGRAMMING	**4**	**0**	**0**	**4**

PREREQUISITES:

Fundamentals knowledge of computer

COURSE OBJECTIVES:

1.	To learn principles of basic programming and interactive programming with a visual programming language like Scratch 3 (MIT).
2.	To provide knowledge in various programming languages and choice of Python as a first programming language.
3.	To understand variables, data types, and expressions.
4.	To learn about conditional coding and loops.
5.	To learn about modular programming with functions.

UNIT	TITLE	PERIODS
1	**Programming Principles Through Visual Programming**	**18**

Using visual programming (Scratch3, MIT) to explore principles of programming, control structures (if/then/else, loops - repeat, wait until, for, repeat until, forever, cloning), events (responding to keyboard, broadcast), motion and movement, animation looks and sounds, interactive gaming and sensing (user input, responding to mouse, callbacks), operators and variables, lists, blocks.

UNIT	TITLE	PERIODS
2	**Getting started Using Python**	**6**

Motivation of learning Python - ease and diversity of application.

UNIT	TITLE	PERIODS
3	**Variables, Data Types, and Expressions**	**16**

Variables, Data Types (strings, numbers, lists, tuples, dictionaries), expressions with each of them, basic functions for Strings (concatenation, reverse, etc), numbers and functions available for numbers.		
UNIT	**TITLE**	**PERIODS**
4	**Conditional Code and Functions**	**18**
Control and conditional code in Python boolean variables, if/else, if/elif/else, loops, range function, list comprehension, and conditional list comprehension, Creating functions for modularity and code reusability, generalization with input parameters to allow for code to be used in different situations.		
UNIT	**TITLE**	**PERIODS**
5	**Object Oriented Programming in Python**	**14**
Class - Object (object) - instantiation (initialization), methods, data encapsulation - Inheritance.		
	TOTAL PERIODS	**72**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Learn principles of basic programming and interactive programming with a visual programming language like Scratch 3 (MIT)	
CO2:	Know various programming languages and choice of Python as a first programming language.	
CO3:	Understand variables, data types, and expressions.	
CO4:	Learn about conditional coding and loops and modular programming with functions.	
CO5:	Learn about OOPS in Python.	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Games by Jon Woodcock, “Coding Projects in Scratch: A Step-by-Step Visual Guide to Coding Your Own Animations”, DK Children publications, 2016.	
2.	Adam Stewart, “Python Programming, Python Programming for Beginners, Python Programming for Intermediates”, Createspace Independent Publications, 2017.	
3.	Reema Thareja, “Python Programming”, Oxford University Press, 2023	
4.	R. Nageswara Rao, “Core Python Programming”, R. Nageswara Rao, DreamTech Press, 2021	
5.	Vamsi Kurama, “Python Programming: A modern Approach”, Pearson India, 2017	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC ELECTRONICS	**4**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	To learn basic principles of electronics - current, voltage, energy, power, frequency, AC and DC
2.	To learn basic components - voltage source, resistor, capacitor, diode, transformers, LEDs, LDR
3.	To learn about basic ICs – Comparators, Voltage regulators, Displays
4.	To learn basics of schematic creation, PCB Layout, manufacturing process, PCB Debug and Testing
5.	To learn features of Software Tools - DRC/ERC Rules, Error debugging, understanding warnings, Connectivity checkers
6.	To Learn about components through hole and SMD/SMT components and their selection

UNIT	TITLE	PERIODS
1	**Energy, Charge, Voltage, Current, Resistance**	**18**

Energy, charge, voltage, current, resistance - resistance of common items around us, parallel and series, voltage (parallel) and current (series) measurement, errors of measurement. Voltage sources, internal resistance in batteries, drawing a simple circuit, Light Emitting Diodes, lumen, power, Energy as Wh, drawing a simple circuit, looking at a built circuit and being able to create a drawing, Introduction to Ohms law, resistor ladders, R-2R ladder, R-R ladder, and golden ratio, LDR, simple photodetector using LDR, KCL and KVL

UNIT	TITLE	PERIODS
2	**Capacitors, RC, Frequency, AC**	**18**

Capacitors – Charge and Voltage, Charge and Current, charging with current source, charging and discharging with resistors – RC time constant concept of frequency – square, triangular and sawtooth waves, Alternating currents, sine wave, circle trigonometry, wave generation with positive feedback and integration, square, triangular, modified triangular to approximate sinusoid, diode and zener diode used for clipping waveforms, impedance of a capacitor, AC coupling, RC delay in context of AC signals, phase delay, low-pass and high-pass filters and impacts on signals, microphones

UNIT	TITLE	PERIODS
3	**Diodes and Rectification, Transformers Voltage Regulators, ACto DC Conversion**	18

Introduction to Diodes – reverse and forward bias, ON voltage, half wave and full wave rectification, peak detector circuit, Circuit to drive LEDs from AC mains, Introduction to zener diodes, AC mains to 6V DC conversion using Zeners, Introduction to voltage regulator ICs, AC mains to DC conversion using regulator ICs. Introduction to transformers – Primary and secondary coils, turns ratio, energy conservation, Introduction to LM78xx series of voltage regulators. AC mains to 5V DC conversion circuit using LM78xx

UNIT	TITLE	PERIODS
4	**PCB Schematic and Layout**	12

EDA (Electronic Design Automation) software and their use, understanding schematics in software. Principles of schematic creation - instance/net naming, use of connectors, routing, block placement, aesthetics. Principles of Symbol Creation - Pin placement, pin grouping, shape, aesthetics. Schematic conventions, Engineering principles in schematic creation - Clarity, signal flow, testability and troubleshooting, Reading component Datasheet for Layout information - footprint, packaging, mounting. Understanding various PCB layers - number of layers, vias, holes, drills. Special PCB layers: soldermask, Keepout. Understanding Gerber files, Principles of PCB layout - Engineering and aesthetics, Ground and Supply planes in 2 layer PCBs, manufacturability, testability. Understanding DRC Rules and implications for manufacturing and assembly, understanding ERC warnings, connectivity errors (LVS), PCB manufacturing and assembly process. LVS - implicit and explicit. Studying some example PCB layouts.

UNIT	TITLE	PERIODS
5	**Soldering Techniques and Component Selection**	6

Soldering and Desoldering Techniques, Safety precautions (mask/fan/goggles), Maintenance and life prolonging techniques, SMD Vs Thru-hole soldering, . Evaluating Components from Datasheet for suitability and selecting, Constraints in using/placing and soldering various components on a PCB such as Switches (push-Button/Sliding), Thermistors, Audio Jacks, Connectors (USB/UART/JLink), Battery Holders, Crystals, Passives of various sizes, Pinheads. BoM creation and Parts ordering from Vendor.

TOTAL PERIODS	**72**

COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Learn basic principles of electronics - current, voltage, energy, power, frequency, AC and DC, low-pass and high-pass filters.
CO2:	Learn basic components - voltage source, resistor, capacitor, diode, Zener diode, LDR, 7-Segment Displays, comparators and 555-Timers
CO3:	Learn about more complex integrated components such as opamps, comparators, IC555
CO4:	Create a PCB Layout of a simple electronic circuit
CO5:	Send a PCB for manufacture
CO6:	Solder and Desolder through-hole as well as SMD/SMT components of various sizes onto the PCB
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Paul Horowitz and Winfield Hill, "The Art of Electronics", Cambridge University Press, 2015.
2.	Yannis P. Tsividis, "A First Lab in Circuits and Electronics" , Oxford University Press, 2018.
3.	R. S. Sedha, "A Textbook of Applied Electronics", S. Chand Limited, 2008.
4.	Sean Westcott, Jean Riescher Westcott, "Basic Electronics Theory and Practice", Mercury Learning and Information, 2020.
5.	Jens Lienig, Juergen Scheible, "Fundamentals of Layout Design for Electronic Circuits", Springer, 2020.
6.	R. Sengupta "Principles of Reliable Soldering Techniques", New age international publishers, 2017.
7.	Douglas Brooks, Johannes Adam, "PCB Design Guide to Via and Trace Currents and Temperatures", Artech House, 2021.
8.	Mike Judd, Keith Brindley , "Soldering in Electronics Assembly", Elsevier Science, 2013.

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	ENGLISH - I	**3**	**0**	**0**	**3**

PREREQUISITES:

Knowledge in English Language, vocabulary

COURSE OBJECTIVES:

1.	To encourage the students to speak English
2.	To enable students to use English in day-to-day communication
3.	To build up their confidence in the usage of English
4.	To expose them to light prose and poetry
5.	To re-introduce them to the basics of grammar

UNIT	TITLE	PERIODS
1	**Prose**	**11**

The Bet- Anton Chekhov - With The Photographer- Stephen Leacock The Portrait of a Lady- Khushwant Singh - On The Face of It- Susan Hill - The Proposal- Anton Chekhov (Play)

UNIT	TITLE	PERIODS
2	**Poetry**	**11**

Say Not The Struggle Naught Availeth-Arthur Hugh Clough - Abu Ben Adhem -James Leigh Hunt-Where the Mind is Without Fear- Rabindranath Tagore-Daffodils:William Wordsworth-Stopping By Woods On A Snowy Evening-Robert Frost

UNIT	TITLE	PERIODS
3	**Spoken Communication**	**11**

Meeting People,ExchangingGreetings,Taking leave-Introducing Yourself- Introducing People To Others-Answering The Phone And Asking For Others-Discussing Hobbies,Likes And Dislikes

UNIT	TITLE	PERIODS
4	**Grammar and Vocabulary**	**10**

Articles-Modal Auxiliaries-Prepositions

UNIT	TITLE	PERIODS
5	**Creating Compositions**	**11**
Report Writing-Summarizing		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Analyze various types of novels and stories and pieces of prose with reference to mathematics and other approaches.	
CO2:	Read and comprehend better.	
CO3:	Communicate in English orally and in writing.	
CO4:	Refer to the dictionary for synonymous expressions and grammar.	
CO5:	Enlarge the vocabulary and understand the structure of sentences and grasp the idea of the author.	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Hornby. A.S," Guide To Patterns And Usage In English(ELBS)", Oxford publisher, 2016.	
2.	Corder, S.Pit," An Intermediate English Practice Book", Orient Longman Publications, Paperback,1974.	
3.	Vallins, G.D "Better English", Macmillan publications,1959.	
4.	Zandvoort," A Handbook Of English Grammar(ELBS)", Longman publications,1975.	
5.	Wood. F.T, "A Remedial English Grammar For Foreign Students", Trinity Publications, 1965.	
6.	Dowling, Dave," Oxford Guide To Effective Writing And Speaking", Oxford University Press; 2nd edition,2005.	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	APPLIED MATHEMATICS	**3**	**0**	**0**	**3**

PREREQUISITES:

Basic Concepts of numbers system, Vector Calculus

COURSE OBJECTIVES:

1.	To learn to revisit mathematical concepts visually.
2.	To learn to interpret integration and differentiation through their application.
3.	To learn matrices and their application.
4.	To learn vector algebra and calculus.

UNIT	TITLE	PERIODS
1	**Mathematical concept through IKS (Indian Knowledge Systems)**	**10**

Bhramagupta's rules of integers. Rajju Ganit (Rope Mathematics) - revisiting circles, measuring perimeter, measuring angles in radians, dividing a circle into any number of parts desired, trigonometry using circles. Visual proofs of "Pythagoras theorem". Pythagoras' theorem and application in - coordinate geometry, equation of circles, and complex numbers.

UNIT	TITLE	PERIODS
2	**Visual Algebra**	**11**

Plotting algebraic expressions, Geogebra (the relation between algebra and geometry), functions - linear, quadratic, cubic functions, exponential, logarithmic. Zeros of an equation (factorization in algebra) as understood and solved visually. Linear algebra and solution of simultaneous equations in 2 D.

UNIT	TITLE	PERIODS
3	**Visual Calculus**	**11**

Differentiation as slope at a point and integration as areas of curves. Application to constant acceleration to get velocity and distance through integration. Integration in continuous time (electronics)/discrete-time (computer science), Integration calculation in computers as FEM.

Differentiation application to find the location of peaks and troughs in curves and second differentiation to find if they are peaks or troughs. Differentiation of polynomial, exponential, and logarithmic expressions.		
UNIT	**TITLE**	**PERIODS**
4	**Vector algebra and vector calculus**	**11**
Vector algebra: scalar and vector products; scalar and vector triple products; geometric applications. Vectors as viewed by mathematicians, physicists, and computer scientists. Differentiation of a vector function; scalar and vector fields. Gradient, divergence, and curl - definitions and physical interpretations; product formulae; curvilinear coordinates. Gauss' and Stokes' theorems and evaluation of integrals over lines, surfaces, and volumes.		
UNIT	**TITLE**	**PERIODS**
5	**Graph Theory**	**11**
Graph Theory - Representation of graphs, Breadth-first search, Depth-first search, Applications of BFS and DFS; Directed Acyclic Graphs - Complexity of BFS and DFS, Topological sorting.		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Demonstrate mathematical concepts visually.	
CO2:	Interpret integration and differentiation visually and through their application.	
CO3:	Understand vector algebra and calculus	
CO4:	Learn how to use Matrices	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Stephen Roberts,"Vector Algebra and Calculus", University of Oxford,2013.	
2.	T. K. Manicavachagom Pillay, T. Natarajan, S. Ganapathy," Algebra – Vol. II", S. Viswanathan Printers & Publishers Pvt. Ltd,11th Revised edition, 2004.	
3.	Visual perspectives on Mathematics https://www.3blue1brown.com/topics/calculus https://www.3blue1brown.com/topics/linear-algebra	
4.	T.A. Sarasvati Amma, "Mathematics in Ancient and Medieval India", Motilal Banarsidass Publishers, 2017	
5.	Narsing Deo, "Graph Theory and Applications", PHI Learning Pvt. Ltd., 2004	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	ESP32 PROGRAMMING IN PYTHON	**0**	**0**	**6**	**3**

PREREQUISITES:

Knowledge in python Programming

COURSE OBJECTIVES:

1.	Understanding programming interface with hardware
2.	Learn basics of python programming
3.	Understanding the basic electronics circuits

UNIT	TITLE	PERIODS
1	**Set Up and First Example**	**108**

1.IDE for python Software for ESP32 microcontroller download, installing,
2.Set up and GUI Interfacing,
3.Blink program - first compilation, troubleshooting set up issues
4.Blink program - change frequency, duty cycle,
5.Python program for seven segment display,
6.Python program to create multiple segments 99-sec timer with switch,
7.Python program and libraries - Reading Accelerometer sensor (I2C)
8.Python program and libraries - Lack of motion alarm - using accelerometer
9.Python program - data logger - recording temperature of a room in an SD card
10.Python program - Control servo with Buttons
11.Python program - Automatic Door sensor using PIR
12.Python program - Working with shift register to controller led
13.Python Program - Relay shield to control bulb.

TOTAL PERIODS	**108**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Program an ESP32 microcontroller to drive an output pin, accept analog inputs and respond to interrupt

CO2:	Understand communication Protocols via the example of I2C and SPI
CO3:	Understand the concept of Data Logging by implementing it
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Meenakshi & Mayank Johri, "Let's learn ESP32 using Micropython"
2.	Online reference: Getting Started with MicroPython on the ESP32
3.	Jansa Selvam, "Learn Micropython with ESP32", Kindle edition, 2022
4.	Marwan Alsabbagh, "MicroPython Cookbook", Packt Publishing, 2019
5.	Agus Kurniawan, "MicroPython for ESP32 Development Workshop", PE Pressm 2018

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC ELECTRONICS LAB	**1**	**0**	**6**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	To learn to use basic lab equipment - DMMs, function generators, Oscilloscope, Breadboards
2.	To learn basic measurement techniques, to learn the limitations of Measurement equipment
3.	To create/enhance an interest in learning electronics
4.	To verify theoretical concepts experimentally
5.	To design small projects using electronics.

UNIT	TITLE	PERIODS
1	**Understanding Lab Equipment & Components**	**18**

Galvanometer/Voltmeter/Ammeter working principles, Batteries and Regulated power supplies, understanding a DMM, resistor color coding, diode functionality, anode cathode identification from markings, LDR theory, switch functionality.

Breadboard structure, Converting back and forth between schematics and breadboard circuits, Breadboarding - reading from schematics, making strong connections, prolonging breadboard life, and creating circuits that are easy to troubleshoot and debug.

Simulator theory, Introduction to LTSPICE, downloading LTSPICE to the computer and using it to simulate all the circuits created on the breadboard. Reading comparator data sheet to identify pins

Introduction to NE555, CD4017& CD4033 and 7-segment displays - Reading datasheet, identifying pins and terminology, in context of NE555 changing frequency via changing RC values,

Introduction to Oscilloscopes: Display, V/div and T/div settings, Channels, AC/DC coupling,

Autoset, Triggerring, Cursors, Basic Theoretical understanding of how an oscilloscope works, Digital oscilloscopes

Introduction to function generators: Settings and their meanings – Frequency, Amplitude, offset, duty cycle, waveshape, input impedance

Sound and frequency: introduction to frequency response, Introduction to the human ear and it's frequency response, introduction to microphones, introduction to musical octaves and their frequencies

Introduction to the 7805 regulator and the 1N4733A Zener diode – Datasheet reading, V-I curves and key parameter extraction

UNIT	TITLE	PERIODS
2	**Laboratory**	**81**

DMM Usage Basics: Voltage, current, Resistance

1. Using a DMM to perform connectivity tests
2. Using regulated power supplies (RPS) and batteries. Using a DMM to verify battery specifications and RPS settings.
3. Using DMM to measure voltages, currents and resistances, verifying Ohms law.
4. Measuring resistance of many items around us. Understanding resistor color coding and verifying color coding with DMM measurements
5. Using DMM to verify Series and parallel Resistor combinations.
6. Using DMM to diode ON Voltage and diode functionality
7. Using DMM to understanding LDR functionality, switch functionality.

Breadboarding/Prototyping

1. Creating simple circuits on the breadboard from schematic
2. Using DMM, Breadboard to verify series and parallel resistor connections
3. Using DMM, Breadboard and Diodes to verify diode ON voltage, reverse bias non-conduction for various Diodes including LEDs of various colors

LTSPICE introduction

1. Downloading LTSpice on to the computer
2. Schematic creation of some simple circuits: Resistor networks that can be broken down into series-parallel networks, Resistor-Diode & Resistor LED circuits
3. Simulation of some simple circuits and verification with DMM measurements

Unit Project: Create an LDR based photodetector circuit

NE555, Counters and 7 Segment displays

1. Using NE555 to blink an LED at various speeds and various ON time percentages. Intuitive understanding of frequency, period and duty cycle and the difficulty of observing higher frequencies via LED blinking
2. Using NE555 to drive a buzzer, Effect of frequency changes on sound
3. NE555 drives a binary counter which in turn drives an LED off each output.
4. NE555 + Binary counters to divide down a frequency(frequency measurement)
5. NE555 + Johnson counter which drives a 7-Segment display.

Unit Project -

Oscilloscope/Function Usage and Introduction

1. Using an oscilloscope to view an output of an NE555 based astable multivibrator at a frequency that human vision cannot perceive. Changing frequency, duty cycle of the square wave via a change in RC values and observe the output on the oscilloscope
2. Simple LED+R circuit that can tell the difference between AC/DC sources
3. Driving an oscilloscope from a function generator – changing waveshape (sine, square, pulse, triangle, sawtooth, arbitrary), frequency, amplitude, offset, slope (triangle waves), duty cycle (Pulse)
4. Creating sawtooth waves from square waves- changing frequency, amplitude and slope
5. Drive an RC filter with a square wave of a given frequency and measure the time delay and rise time and relate to theoretical calculations.

Frequency and Sound

1. Use function generator to drive Buzzer. Change all parameters (frequency, amplitude, duty cycle, offset, waveshape) and observe their effect on sound. Observe correlation between sound and oscilloscope display. Frequency Vs Sound, Amplitude Vs Sound
2. Keep the amplitude constant and vary the frequency and observe the effect of frequency on sound and from here, roughly map the frequency response of the human ear
3. Use the microphone output to drive a Buzzer and observe the buzzer input on the oscilloscope screen
4. Use a microphone to create a sound detection circuit
5. Effect of filtering on sound and waveshape: Use the function generator to drive an RC filter and use the output to drive a buzzer (via a buffer)
6. Use the NE555 to drive a buzzer. Change the RC values to get different frequencies

RC Filtering& Sinusoids

1. Drive an RC filter with a sinusoid of a given frequency and observe the output on the oscilloscope. From the oscilloscope, extract the attenuation and phase delay and compare these with theoretical calculations
2. For the same RC filter, extract the frequency response. From the phase and amplitude response, extract the 3-dB bandwidth

3. Drive the same RC filter with a square wave (choose frequency) with a view to extracting the time constant from the oscilloscope screen. The relation between the time constant and the 3-dB bandwidth?

Alternating current

1. Take the AC mains to a DMM with the appropriate setting and measure the RMS value of the AC mains. Is it possible to measure frequency and Amplitude?
2. Take the AC mains to a voltage divider of ratio 1:10 and observe the output on the oscilloscope screen. From what is observed on the screen, estimate the frequency, RMS value and amplitude of the AC mains.
3. Take the AC mains to a 12:1 transformer and observe the secondary output on an oscilloscope. Relate the turns ratio to the primary and secondary amplitude
4. From the secondary of the transformer, Create a half wave rectifier and a full wave rectifier and observe both input and output for both variants on the oscilloscope screen
5. Create a peak detector circuit from the Full wave rectifier output. Observe the waveform for various loads ranging from 10K to 10 Ohms. Observe the waveforms for various Capacitor values ranging from 1uF to 470uF
6. Use a 7805 to obtain a 5v regulated DC supply
7. Repeat 6 with a 1N4733A Zener diode

UNIT	TITLE	PERIODS
3	**Unit Projects**	**27**
1. LDR photo-detecter 2. Water level monitor 3. Create a Casio/Keyboard 4. AC mains to 12V DC creation using transformers		
	TOTAL PERIODS	**126**

COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Use basic lab equipment to test various components, resistors, diodes, LDRs
CO2:	Getting into the habit of Verifying all theoretical concepts experimentally
CO3:	Debug/troubleshoot circuits and identify faults in equipment
CO4:	Use Datasheets effectively, verify datasheets
CO5:	Design small projects using electronics.

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Paul Horowitz and Winfield Hill, “The Art of Electronics”, Cambridge University Press, 2015.

2.	Yannis P. Tsividis, “A First Lab in Circuits and Electronics”, Oxford University Press, 2018.
3.	R. S. Sedha, “A Textbook of Applied Electronics”, S. Chand Limited, 2008.
4.	Sean Westcott, Jean Riescher Westcott, “Basic Electronics Theory and Practice”, Mercury Learning and Information, 2020.
5.	K. Krishna Murty, “Over 50 Exciting Electronics Experiments”, Pustak Mahal New Delhi, 2010

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	PCB DESIGN AND EDA LAB	**0**	**0**	**6**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	To learn schematic creation, PCB Layout, Component Soldering, PCB Debug and Testing
2.	To learn to use software Tools and their features - DRC/ERC Rules, Error debugging, understanding warnings, Connectivity checkers
3.	Soldering Techniques for through-hole and simple SMD/SMT components
4.	To design small projects on a PCB, sending them for manufacture, part ordering, Soldering and testing and debugging the manufactured PCBs

UNIT	TITLE	PERIODS
1	**Schematic Creation**	**18**

1. PCB Design Software download and installation,
2. Software Interface navigation
3. Using ultralibrarian/GitHub for symbol and footprint libraries, creating own symbols
4. Create Schematic and Bill of materials for each of the example projects and build a bill of materials. In each case, Create the same circuit in LTSPICE and simulate, proving equivalence of the schematic created in the PCB design software with schematic used in LTspice, Creating a schematic review document mentioning debug and testing options
    a. NE555/741 based Blinky
    b. 555/741 based buzzer
    c. Water Level monitor
    d. AC mains to 12 V DC regulator

UNIT	TITLE	PERIODS
2	**PCB Layout**	**36**

1. Layout software interface navigation
2. Creation of PCB layout for each of the above software projects

a. DRC/LVS error debug
b. ERC warning Debug

3. Outline the Debug strategy for each of the projects
    a. Using 0 Ohm resistors
    b. Using connectors with sleeves
4. System Level
    a. Dimensions and topology used for ground plane
    b. Routing and dimensions of power lines
    c. Routing of sensitive lives
    d. Use of Decaps at power pins
5. Gerber File creation and upload to manufacturer website. Two variants created
6. Layout review documentation
    a. Justify system level decisions
    b. Justify debug and testing strategy
    c. Review match between component footprints and layout for each component

UNIT	TITLE	PERIODS
3	**Soldering Techniques and Debug**	**36**

1. Order parts from the Vendor based on reading the datasheet and functional requirements
2. Test each ordered component on the breadboard before soldering
3. Solder the components on a general purpose through-hole PCB using through hole components and testing connections for robustness and perform connectivity tests after making connections
4. Desolder thecomponents without causing pad liftoff using heat gun and soldering iron
5. Create a component and node matrix to keep track of connections made
6. Locate and Debug bad connections or no-connections Locating solder shorts, Soldering SMD components to the PCBs, use of a heat gun, soldering ICs with QFN packages, soldering ICs with QFP packages

UNIT	TITLE	PERIODS
4	**PCB Bench Testing and Debug**	**18**

1. Power up the circuit
2. Measure the voltage of each and compare with theory
3. Debug any significant variations between measurements and theoretical expectations
    a. Circuit Debugging techniques,
    b. debugging no-connections and shorts,
    c. detecting faulty components
    d. Desolder defective components and solder working ones in their place
4. bench validation and characterization
    a. effective testing circuit under different circumstances using different components
    b. circuit characterization and comparison with spice simulations

	TOTAL PERIODS	**108**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Create a PCB Layout of a simple electronic circuit, select components, evaluate suitability from datasheet and order from vendors	
CO2:	Send a PCB for manufacture	
CO3:	Solder and Desolder Thru hole as well as SMD/SMT components of various sizes onto the PCB	
CO4:	Test and debug the PCB when it comes back from manufacturer	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Mike Judd, Keith Brindley , "Soldering in Electronics Assembly", Elsevier Science, 2013.	
2.	Douglas Brooks, Johannes Adam, "PCB Design Guide to Via and Trace Currents and Temperatures", Artech House, 2021.	
3.	R. Sengupta "Principles of Reliable Soldering Techniques", New age international publishers, 2017.	
4.	Jens Lienig, Juergen Scheible, "Fundamentals of Layout Design for Electronic Circuits", Springer, 2020.	
5.	R.S. Khandpur, "Printed Circuit Board: Design, Fabrication, Assembly and Testing", Tata McGraw-Hill Education, 2005	

Course Code	Course Title	Periods per week			Credits
	ESSENTIAL SCIENCE (THEORY AND PRACTICE)	L	T	P	
		2	**0**	**2**	**3**

PREREQUISITES:

Fundamental knowledge of Physics

COURSE OBJECTIVES:

1.	To learn to explain the macro physical phenomenon using atomic model
2.	To learn to interpret and model physical phenomena using calculus

UNIT	TITLE	PERIODS
1	**Atomic and molecular physics**	**18**

Atomic picture of matter, atoms as building blocks. Using atoms to understand - everyday phenomena - air pressure, dynamic equilibrium, states of matter, melting and boiling point, things expand on heating, evaporation, diffusion, and sound.

UNIT	TITLE	PERIODS
2	**Interpret and model physical phenomenon with calculus**	**18**

Rates and derivatives, straight-line kinematics - the relationship between distance, speed, and acceleration. Integration to work backward from acceleration, speed, and distance. Description of the distance covered by a falling object as a function of time. Being able to draw this visually. Potential energy, kinetic energy, and conservation of energy. Address other physical phenomena with derivatives including voltage and current of a capacitor.

LABORATORY	**36**

1.Building lattice structure (tetrahedron) for Carbon,
2. Silicon used in semiconductors -
Air pressure experiments (macro phenomenon based on atomic structure):
- with a balloon,- sheets of paper, etc
3. States of matter experiment: heating experiment, evaporation, and condensation -
4. Diffusion experiment: ink and water. - Ink drop in hot and cold water,- Puncture of the balloon
- Understanding rate -- water from a tap. What is the rate of flow?

5. Measuring constant speed and distance and checking repeatability (use Incline slope for different speeds) - Measuring speed of falling objects using video camera - Potential energy: changing mass, changing distance determining impact with stress gauge - Pendulum - potential to kinetic energy and conservation of energy with stress gauge - Conservation of energy through conservation of momentum (football and tennis ball) - Tracing the voltage of a capacitor with constant current (simulation or setup).	
TOTAL PERIODS	**72**
COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Understand the macro physical phenomenon using atomic model
CO2:	Interpret and model physical phenomena using calculus
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Balaji Sampath, “The Aha Guide to Atoms”, AhaGuru Education Technology publications, Third Edition,2015.
2.	Yannis Tsividis, “Operation and Modeling of the MOS Transistor”, Oxford Press Publications,1999.
3.	Halliday and Resnick, “Principles of Physics, Extended, 12ed (An Indian Adaptation)”, 2023
4.	David Acheson, "The Calculus Story: A Mathematical Adventure", Oxford University press, 2017
5.	Fujitaki, Matsda et.al, “The Manga guide to Electricity”, No starch press, 2009

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	INDIAN CULTURE AND UNIVERSAL VALUES - I	**1**	**0**	**4**	**3**

PREREQUISITES:	
NIL / Course Code – Course Title / Topics	
COURSE OBJECTIVES:	
1.	To understand the evolutionary steps of nature and man
2.	To learn different systems of yoga and their significance
3.	To learn Radical Transformational Leadership tools and distinctions and to apply what I stand for (care about) in my everyday life.
4.	To learn systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment with universal values.

UNIT	TITLE	PERIODS
1	**Introduction to Yoga**	**6**
Meaning & relevance of yoga in human life; Fundamentals of yoga		
UNIT	**TITLE**	**PERIODS**
2	**Evolution: Progressive self-manifestation of Nature in man**	**6**
Bodily life, mental life, beyond mental life: higher life; Planes of consciousness; Involution		
UNIT	**TITLE**	**PERIODS**
3	**Integral Yoga**	**6**
Introduction to parts of the being, Aim of Integral Yoga		
LABORATORY		**72**
1. Sourcing inner capacities		

2. My Four Profiles
3. Distinction: Courage and Bravery
4. Background Conversations & Listening
5. Watch 12 Angry Men and listing leadership traits
6. “You are my Hero” Noticing & Transforming disempowering cultural norms. Read the book; discuss in Pairs.
7. Systems principles-Film: Story of Stuff
8.Architecture for Equitable Change: Partial & Conscious-Full Spectrum Response Model
9. Designing my breakthrough Initiative using CFSR
10.Designing my breakthrough Initiative---Beyond Problem-solving--Realize & respond
11. Background Conversations & Leadership
12. Speaking powerfully to inspiring others to commit to an action— speaking about my BTI
13. Giving feedback to foster growth
14. Complaints as a commitment for action

TOTAL PERIODS	**90**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Explain the evolutionary steps of nature and man
CO2:	To know different systems of yoga and their significance and limitations and understand the synthesis in Integral Yoga in its essence
CO3:	To apply Radical Transformational Leadership tools and distinctions and to apply what I stand for (care about) in my everyday life.
CO4:	To use systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment with universal values.

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION

1.	Sri Aurobindo, “The Synthesis of Yoga”, Sri Aurobindo Ashram Publications,1921.
2.	Indian Psychology Institute. https://infinityinadrop.net/infinityfiles/0-4-3-evo-longterm.php
3.	Indian Psychology Institute. https://infinityinadrop.net/infinityfiles/0-3-1d-cons-integral.php
4.	Monica Sharma, “Radical Transformational Leadership: Strategic Action for Change”, North Atlantic Publications,Berkeley,California,2017.
5.	William Hart, “The Art of Living: Vipassana Meditation as Taught by S.N. Goenka”, Embassy Books, 1988

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	DIGITAL GATES AND IC LAYOUT	**4**	**0**	**0**	**4**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	Understand Digital logic and what it means
2.	Create a combinational Digital circuit given any boolean function and vice versa
3.	Understand the concept of a digital memory
4.	Understand digital circuits of medium complexity
5.	Understand the basics of the manufacturing process and Create layouts of simple digital circuits

UNIT	TITLE	PERIODS
1	**Boolean Logic with Mechanical And Electrical Elements**	**12**

Gates based on mechanical Switches - Use of a mechanical ON-OFF switch to implement an inverter - LED glows when switch is off. Use of two switches to implement AND, OR, NAND, NOR gates. Introduction to SPDT switches, using an SPDT switch to implement XOR logic. Gates based on Electronic elements, Voltage Levels representing mechanical ON/OFF, Truth Tables, Boolean expressions, Sum of Products, Truth table ←→ Expression ←→Schematic conversion. Boolean Algebra - identities, Simplification, Karnaugh Maps, Introduction to SR and JK Latches

UNIT	TITLE	PERIODS
2	**Combinational Digital Circuits at Transistor Level**	**12**

MOS Transistor as a switch, MOS transistor simple model for Digital circuits, CMOS inverter, CMOS logic gates – NAND, NOR, AND, OR, XOR, XNOR. Other common digital functions – Multiplexors, Decoders, level shifters, Function ←→ Transistor level realization of any logical expression, Pass gate logic. Design parameters - noise margin, speed, power consumption, glitching.

UNIT	TITLE	PERIODS
3	**Simple Memory Elements**	**12**

Memory elements, back to back inverter and positive feedback, SR/JK Latches, D-Latch, Flip Flops – SR/JK/D created from 2 input Logic gates, Latch Vs Flip Flop, Edge Vs Level triggering, set up and hold time, Clocks, Synchronous Vs Asynchronous Flip flops, shift register, Binary counter		
UNIT	**TITLE**	**PERIODS**
4	**Digital Blocks of Medium Complexity**	**12**
Memory Elements - ROM, RAM. Finite State Machines, Programmable Logic Arrays, FIFO		
UNIT	**TITLE**	**PERIODS**
5	**Digital IC Layout**	**24**
Intrinsic and extrinsic semiconductors, Doping (P/N), manufacturing process and fabrication steps, Basic CMOS technologies (well processes), interconnects, circuit elements, Layer representations (Base and Metal layers), Stick diagrams, Design rules and DRC, schematic-layout connectivity equivalence & LVS, Principles of Layout Design (Floorplanning, routing, power/ground planes), Techniques for reducing eye-strain and maintain physical health.		
	TOTAL PERIODS	**72**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Understand Digital logic and what it means	
CO2:	Create a combinational Digital circuit given any boolean function and vice versa	
CO3:	Understand the concept of a digital memory	
CO4:	Understand digital circuits of medium complexity	
CO5:	Understand the basics of the manufacturing process and Create layouts of simple digital circuits	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Adel S. Sedra, Kenneth C. (KC) Smith, Tony Chan Carusone, and Vincent Gaudet, “Microelectronic Circuits” Oxford University Press, 2019.	
2.	Anant Agarwal, Jeffrey H. Lang, “Foundation of Analog and Digital Electronic Circuits”, Elsevier, 2005.	
3.	Jan M. Rabaey, Anantha chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits, A Design perspective”, Prentice Hall, 1996.	
4.	Neil H.E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI Design”, Addison Wesley publishing company, 1993.	
5.	Zvi Kohavi, “Switching and Finite Automata Theory”, Tata McGraw-Hill, 2016	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	ENGLISH - II	**3**	**0**	**0**	**3**

PREREQUISITES:

English I

COURSE OBJECTIVES:

1.	To encourage the students to speak English
2.	To enable students to use English in day-to-day communication
3.	To build up their confidence in the usage of English
4.	To expose them to light prose and poetry
5.	To develop their written and communicative competence
6.	To re-introduce them to the basics of grammar

UNIT	TITLE	PERIODS
1	**Prose**	**11**

How much Land Does A Man Need: Leo Tolstoy-Penalty: Premchand -The Painter Of Signs: R K Narayan-Arms And The Man: George Bernard Shaw (Play)

UNIT	TITLE	PERIODS
2	**Poetry**	**11**

Do Not Go Gentle Into That Good Night: Dylan Thomas-If : Rudyard Kipling-Ozymandias: Percy Bysshe Shelley-Ode To Autumn: John Keats-The Dungeon: Samuel Taylor Coleridge

UNIT	TITLE	PERIODS
3	**Spoken Communication**	**11**

The Art Of Public Speaking-Ability To Explain A Topic To Your Peers-Ability To understand Native Speakers And Repeat Sentences

UNIT	TITLE	PERIODS
4	**Grammar And Vocabulary**	**10**

Tenses, punctuation,voices

UNIT	TITLE	PERIODS

5	**Creating Compositions**	**11**
Essay Writing-Formal Letter Writing		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Read and appreciate poems on their own.	
CO2:	Analyze poetic texts using appropriate terms such as diction, tone, imagery, figures of speech, etc.	
CO3:	Interpret a poem based on contextual evidence	
CO4:	Analyze various types of novels and stories and pieces of prose with reference to thematics and other approaches.	
CO5:	Read and comprehend better.	
CO6:	Communicate in English orally and in writing.	
CO7:	Refer to the dictionary for synonymous expressions and grammar.	
CO8:	Enlarge the vocabulary and understand the structure of sentences and grasp the idea of the author.	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Hornby A.S,"A Guide to Patterns and Usage in English", ELBS Eight Impression Publications,London,1962	
2.	Corder S Pit , "An Intermediate English Practice Book", Orient Longman Publications,1988.	
3.	Vallins.G.D, "Good English:How To Write It", Pan Macmillan Publications,1951.	
4.	Vallins G.D, "Better English", Pan Publications,1959.	
5.	Zandvoort, "A Handbook Of English Grammar(ELBS) 1975.	
6.	Wood F.T, "A Remedial English Grammar For Foreign Students", Trinity Publications, 1965.	
7.	Dowling Dave, "Oxford Guide To Effective Writing And Speaking", Oxford University Publications,2013.	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	APPLIED MATHEMATICS FOR ELECTRONICS - I	**3**	**0**	**0**	**3**

PREREQUISITES:

Applied Mathematics

COURSE OBJECTIVES:

1.	To revisit the concepts of quadratic equations, Complex numbers, trigonometry and calculus
2.	Applying the mathematical concepts to understand capacitor operation and vice versa
3.	Introduction to differential equations
4.	An introduction to Laplace transforms and their applications to solving differential equations

UNIT	TITLE	PERIODS
1	**Complex Numbers**	**12**

A review of real numbers, square root of a negative real number, real and imaginary components of a complex number, operations on complex numbers – addition, subtraction, multiplication, division. Complex number representation on a cartesian plane - angle & magnitude, effect of multiplication and division on angle and magnitude, introduction to e, exp(jΩ), square root/cube root, exponential operations on complex numbers. Quick review of quadratic equations, quadratic equations with complex roots.

UNIT	TITLE	PERIODS
2	**Mathematics of the Capacitor**	**10**

Review of Trigonometric functions – sin & cos. Derivatives and integrals of trigonometric functions, numerical methods to compute integrals and derivates using MS XL and python, Review of capacitor operation and equation, capacitor response to sinusoidal stimulus – V-I relationships & Frequency

UNIT	TITLE	PERIODS
3	**Differential Equations**	**10**

Introduction and motivation – differential equations in electronics, differential equations involving polynomial functions, trigonometric functions, exponential functions and a combination of the three, solving linear first order differential equations, second order differential equations, higher order differential equations		
UNIT	**TITLE**	**PERIODS**
4	**Laplace Transforms And Time Domain Equivalence**	**10**
Introduction to the step function, introduction to the laplace transform, computing laplace transform for some simple algebraic functions, trigonometic and exponential functions. The inverse laplace transform, going between time domain and laplace domain representations		
UNIT	**TITLE**	**PERIODS**
5	**Laplace Transform And Differential Equations**	**12**
laplace transform of a function and it's derivative, effect of integration on the laplace transform, converting a differential equation into an algebraic equation, roots of a quadratic equation Vs solution to a differential equation, using laplace transforms to solve differential equation		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Understand the basic mathematical concepts related to the operation of frequency dependent electronic components	
CO2:	Approach electronic circuits from a mathematical perspective	
CO3:	Solve simple linear differential equations	
CO4:	Apply Laplace transforms to solving simple differential equations	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Y.H.Gangadharaiah, N. Sandeep "Engineering applications of Laplace Transform", Cambridge Scholars Publishing, 2021.	
2.	Erwin Kreyszig, " Advanced Engineering Mathematics", Wiley India, 1979	
3.	G.N. Berman, "A course in Mathematical Analysis", MIR prublishers Moscow, 1965	
4.	B.S. Grewal, " Higher Engineering Mathematics", Khanna Publishers, 2020	
5.	H.K. Dass, " Advanced Engineering Mathematics", S. Chand Publishing, 2021	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC DIGITAL GATES LAB	**1**	**0**	**4**	**3**

PREREQUISITES:

1. Basic Electronics
2. Basic Electronics Lab

COURSE OBJECTIVES:

1.	To learn how to use basic electromechanical components like switches, relays, motors, displays
2.	To learn how to use simple digital gates and memory elements
3.	To learn to debug combinational circuits implementing a digital function
4.	To learn to use common digital chips such counters, timers and clocks
5.	To design small projects using knowledge gained

UNIT	TITLE	PERIODS
1	**Basic Electromechanical Components**	**18**

Switch theory – On/OFF resistance, control mechanism – mechanical, electrical, electromechanical types - sliding, SPST, SPDT, DPDT, introduction to 7-segment displays, relays and DC motors,

LABORATORY **72**

BOOLEAN LOGIC WITH MECHANICAL ELEMENTS

1. Testing and characterization of ON/OFF, SPST, SPDT, DPDT and sliding switches
2. 7 segment display wiring to display any number from 0-9.
3. Use a single switch to make a seven segment display switch between displaying two characters. Can this be done with a single ON-OFF switch?
4. Use two ON/OFF switches to implement common logic gates (INV, AND, OR, NAND, NOR)
5. Use an SPDT switch to make either of two LEDs glow based on a throw.
6. Use two SPDT switches to implement the XOR function as seen in a house wiring. When both on switches are thrown in same configuration, the LED must be off, but when they are thrown in different orientations, the LED must turn on

APPLICATIONS OF BOOLEAN LOGIC WITH ELECTRONIC GATES

1. Bench testing of common 2-input digital gates
2. Synthesis and testing of three variable Boolean function from 2 input gates
3. Introduction to relays and testing relay function on a breadboard
4. introduction to DC motors and testing on a breadboard
5. Create an Opamp-LDR set up with 2 LDRs and implement various digital functions with abstractions for 1 and 0 at the input depending on whether light is allowed to fall on the LED or not. Implement various digital gates with the output going to light up an LED which a lighted LED being abstracted as 1
6. Repeat previous, but this time, instead of lighting an LED, drive a DC motor
7. Repeat 5., but this time instead of just lighting an LED, flash it. Use a 555 timer if required
8. Repeat 6., but this time, have three outcomes, DC motor rotates clockwise, anticlockwise and not at all

MEMORY ELEMENTS

1. Bench testing of SR/JK Latches created from 2 input Logic gates
2. Use SR latch with LDR photodetector to implement the following function - hand wave on one LDR1 turns on LED1 and keeps it glowing and turns off LDR2. Handwave on LDR2 turns on LED2 and keeps it glowing and turns off LDR1. Reset button turns off both LEDs.
3. Lab Challenge 2: Modify challenge 1 to have a Left → Right handwave turn on on LED1 and turn off LED2 while R → wave is vice versa.
4. Lab Challenge 3 (2-bit counter): Single LDR, Odd numbered hand waves turn on the LED1 and turn off LED2 while even numbered hand waves are vice versa.
5. Bench testing of D Flip Flops and JK/SR Flip Flops and a practical understanding of how these differ from Flip flops

COUNTER APPLICATIONS

1. Using a 555 timer chip and a Binary counter to make 10 LEDs turn on and off in sequence
2. Using a binary counter to divide down the input frequency by any given factor
3. Use a 555 timer chip and a Johnson counter to create a seconds clock to count up to 10 seconds with a resolution of 0.1s
4. Create a clock that can count up to 10 minutes with a resolution of 1 second

Create a 3 bit binary counter with a cascade of D flip flops

TOTAL PERIODS	**90**

COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Able to use simple electromechanical components
CO2:	Use simple digital gates, memory elements and chips of mid level complexity

CO3:	Create, test and debug a combinational Digital circuit given any boolean function
CO4:	Create and Debug some digital applications
CO5:	Use common Digital components given the datasheets
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Adel S. Sedra, Kenneth C. (KC) Smith, Tony Chan Carusone, and Vincent Gaudet, “Microelectronic Circuits” Oxford University Press, 2019.
2.	Anant Agarwal, Jeffrey H. Lang, “Foundation of Analog and Digital Electronic Circuits”, Elsevier, 2005.
3.	Jan M. Rabaey, Anantha chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits, A Design perspective”, Prentice Hall, 1996
4.	Zvi Kohavi, “Switching and Finite Automata Theory”, Tata McGraw-Hill, 2016
5.	Neil H.E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI Design”, Addison Wesley publishing company, 1993.

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	IC LAYOUT – DIGITAL LAB (THEORY AND PRACTICE)	**1**	**0**	**6**	**4**

PREREQUISITES:

Basic Electronics
Basic Electronic Lab
PCB Design and EDA Lab

COURSE OBJECTIVES:

1.	Understand and customize the underlying CAD Environment
2.	Layout digital gates, functions, memory elements and circuits of mid level complexity
3.	Debug tool error messages
4.	Apply good layout practices learnt in theory
5.	Debug layout errors

UNIT	TITLE	PERIODS
1	**Setting Up and Understanding the Tool Environment**	**18**

Software installation and interface navigation - Library, cell views (schematic, symbol and layout). Creation of N/PMOS devices from first principles (no std cells) - using layers and creating shapes by hand, Running DRC/LVS/ERC and debugging error messages, basic bindkey usage, modifying bindkey file. Understanding basic database setup - environment/library/model files

LABORATORY	**108**

Basic Layout

1. Layout of basic CMOS digital gates: inverter, NAND, NOR, AND, OR, XOR, XNOR
2. Passgate Logic Layout for the same gates as above
3. Layout of commonly used digital functions: Multiplexor, Decoder, encoder, Shift register
4. Layout of a digital function with a function of mid level complexity
5. Memory Element Layout: Latches and Flip-Flops

Mid Level complexity

1. Binary counter
2. 7 segment decoder
3. Frequency divider
4. Small ROM cell with decoder
5. Simple SRAM memory Cell

Course Project: Students can choose from several Digital systems of medium complexity -

1. Memories: ROM, RAM (DRAM
2. Logic: PLA, ALU
3. Combination: FSM

TOTAL PERIODS	**126**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Able to create schematics, symbols and hand layout of commonly used Digital structures
CO2:	Able to debug DRC/LVS error messages
CO3:	Able to debug simple set-up issues in the database
CO4:	Learn good layout practices to improve efficiency, reduce layout time
CO5:	Learn good practice to maintain eye and physical health

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION

1.	Neil H.E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI Design”, Addison Wesley publishing company, 1993.
2.	Hubert Kaeslin, “Digital Integrated Circuit Design”, Cambridge university press, 2008.
3.	Tertulien Ndjountche, “Digital Electronics 1”, Wiley, 2016.
4.	Zvi Kohavi, “Switching and Finite Automata Theory”, Tata McGraw-Hill, 2016
5.	Gopalakrishnan & Rutenbar, “Direct Transistor-Level Layout for Digital Blocks”, Springer-Verlag, 2004

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	INTEGRAL YOGA AND VALUE EMBODIED LEADERSHIP - I	**1**	**0**	**4**	**3**

PREREQUISITES:

Indian Culture and Universal Values - I

COURSE OBJECTIVES:

1.	To incorporate aspects of integral yoga into life with meditation and reflection
2.	To incorporate aspects of integral yoga into life with surya namaskar
3.	To integrate Radical Transformational Leadership tools in everyday practice.
4.	To design projects for system and cultural shift from universal values
5.	To learn distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

UNIT	TITLE	PERIODS
1	**Review of Integral Yoga Principles**	**9**

Review Integral Yoga - physical, mental, vital alignment with psychic

UNIT	TITLE	PERIODS
2	**RTL (Radical Transformational Leadership) Book Reading**	**9**

Understanding the praxis around the world around RTL

LABORATORY	**72**

1.To learn and incorporate daily meditation
2.To learn and incorporate Surya namaskar
3.To reflect weekly on the progress made physically and mentally
4.Reflection on the tools applied in day to day life.
5.Conversations for clarity and refreshers.
6.Refresher on design templates and design and refining the breakthrough initiative at college.

TOTAL PERIODS	**90**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Develop in meditation and reflection
CO2:	Develop physically through suryanamaskar
CO3:	Use Radical Transformational Leadership tools in everyday practice.
CO4:	Design projects for system and cultural shift from universal values
CO5:	Notice distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Daniel Goleman and Richard Davidson,"Altered Traits: Science Reveals How Meditation Changes Your Mind, Brain, and Body",Avery Publications,2017.
2.	Monica Sharma,"Radical Transformational Leadership: Strategic Action for Change", North Atlantic Publications,Berkeley,California,2017.
3.	Sri Aurobindo, "The Synthesis of Yoga", Sri Aurobindo Ashram Publication Department, Pondicherry, 2010
4.	Sri Aurobindo, "Integral Yoga", Lotus Press, 2015
5.	Ashesh Gupta, "An introduction to Integral Yoga", Ashesh Joshi, First Edition, 2017

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC CIRCUIT THEORY	**4**	**0**	**0**	**4**

PREREQUISITES:

Basic Electronics
Applied Mathematics
Applied Mathematics for Electronics - I

COURSE OBJECTIVES:

1.	To learn basic circuit and device Principles: Conservation laws, Device operation
2.	To learn circuit operation in a circuit consisting of multiple components
3.	To learn to analyze common circuit configurations
4.	To learn common circuit applications

UNIT	TITLE	PERIODS
1	**Resistive Networks**	**12**

Kirchoff's Current Laws, Kirchoff's Voltage Laws, Conservation Laws, Current sources, Independent voltage and current sources, Resistive networks, Superposition with independent voltage and current sources, Nodal and Loop Analysis, transconductors (voltage controlled current source)

UNIT	TITLE	PERIODS
2	**Operational Amplifiers**	**12**

Operational Amplifiers - Pins, features & Parameters, reading and understanding datasheet, Negative feedback and virtual ground, Simple Opamp-R circuits (Gain, transimpedance, summing, difference)

UNIT	TITLE	PERIODS
3	**Active R Circuits**	**16**

Diodes - modes of operation, ON Voltage, temperature dependence, Diode circuits with resistors, Zeners - modes, breakdown voltage, biasing with resistors. BJTs - Introduction, NPN/PNP, modes, parameters, BJT circuits with resistors. MOSFETs - Introduction,

NMOS/PMOS, modes, parameters, simple MOSFET-R circuits, Opamp circuits with diodes and transistors (eg: Log Amp, Temperature sensor).		
UNIT	**TITLE**	**PERIODS**
4	**Capacitors and RC Circuits**	**16**
Capacitor as a storage element, charging and discharging, I-V relationship, Charge conservation, Series and parallel combination, Charge sharing between capacitors, Capacitive circuits with DC Voltage sources and switch combinations, Capacitive impedance (DC Vs AC). Applications - Supply Doubler and Tripler using diodes and capacitors. RC Circuit - as a delay element, Time constants, response to Step, response to square wave and sinusoidal inputs, as a low pass and high pass filter.		
UNIT	**TITLE**	**PERIODS**
5	**Active RC Circuits**	**16**
Op-amp RC circuits - integrator, multivibrator (introduction positive feedback), Filters with Gain. NE555 IC - Changing frequency and duty cycle by changing R/C, monostable and Astable operation, driving an LED and Buzzer. Diode RC circuit: Peak Detector, BJT-RC circuits: Astable multivibrator		
	TOTAL PERIODS	**72**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	figure out the operation of simple circuits containing R, C ,Diodes, Transistors and Opamps	
CO2:	debug/troubleshoot a simple electronic circuit given the schematic and operation.	
CO3:	create a simple electronic circuit given the desired operation	
CO4:	modify an electronic circuit with the same operation but to fit another set of specifications.	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Adel S. Sedra, Kenneth C. (KC) Smith, Tony Chan Carusone, and Vincent Gaudet, “Microelectronic Circuits” Oxford University Press, 2019.	
2.	Anant Agarwal, Jeffrey H. Lang, “Foundation of Analog and Digital Electronic Circuits”, Elsevier, 2005.	
3.	Charles Platt, “Encyclopedia of Electronic Components Volume 1”, O'Reilly Media, Incorporated, 2012.	
4.	W. H. Dennis, “Electronic Components and Systems”, Elsevier Science, 2013	
5.	Chakrabarti, “Circuit Theory: Analysis and Synthesis”, Dhanpat Rai Publications, 2017	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	DIGITAL LOGIC DESIGN	**4**	**0**	**0**	**4**

PREREQUISITES:

Introduction to Programming
ESP32 Programming in Python
Basic Digital Gates Lab
Digital Gates and IC Layout

COURSE OBJECTIVES:

1.	To introduce students to verilog and systemverilog
2.	To introduce circuit modeling and testbench creation
3.	To learn systematic debug techniques

UNIT	TITLE	PERIODS
1	**Introduction To Verilog & SystemVerilog**	**8**

Hardware description languages, Verilog/systemverilog Rules and Syntax, Keywords and identifiers, statements and operators, reg vs wire connections, continuous assignments Vs memory, modules, ports, port modes and datatypes, language structure, code testing and evaluation

UNIT	TITLE	PERIODS
2	**Modeling Combinational Circuits**	**16**

Combinational circuits - methods of modeling, the concept of a continuous assignment, begin-endmodule constructs, the assign statement, the always block, the case statement, the if-else condition, the always block, the always_comb construct, the delay operator, the timescale declaration. Creating testbenches - the initial statement, the finish() statement, the random statement. Modeling and testing basic Digital gates – INV/NAND/NOR/AND/OR/XOR, encoder, decoder, multiplexor, half and full adders, modeling any boolean function, gate level Vs Behavioral modeling

UNIT	TITLE	PERIODS
3	**Modeling Basic Sequential Circuits**	**16**

Concept of time and Clock, the forever statement, the concept of an event, posedge & negedge as events, Blocking Vs Non-blocking assignments. Modeling SR/JK/D Latches, Modeling

SR/JK/D Flip Flops, Modeling a 3-bit Binary counter, Serial flip flops, Modeling all blocks with Blocking as well as Non blocking assignments and contrasting.		
UNIT	**TITLE**	**PERIODS**
4	**Modeling Complex Sequential Circuits**	**16**
Modeling counter reset/clear and enables, reading datasheets of commercially available counters, Modeling the CD4017, CD4033 and the LS74161 counters, shift register modeling, introduction to deglitchers, deglitcher modeling and introduction to verilog parameters, symmetric and asymmetric deglitchers. The pulse extension function, pulse extenders, modeling pulse extender, modeling pulse extenders with deglitch functionality		
UNIT	**TITLE**	**PERIODS**
5	**Modeling Complex Digital Circuits**	**16**
The readmemh and readmemb commands, introduction to Finite State Machines, Modeling a Finite State Machine, Modeling an ALU, PLA, ROM/RAM, SRAM/DRAM		
	TOTAL PERIODS	**72**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Create Models for digital functions in verilog	
CO2:	create testbenches in systemverilog	
CO3:	Debug models	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Samir Palnitkar, " Verilog HDL : A Guide to Digital Design and Synthesis", Pearson Education, 2003	
2.	Suman Lata Tripathi, Sobhit Saxena, " Digital VLSI Design and Simulation with Verilog", Wiley, 2021	
3.	M. Morris Mano, "Digital Logic and Computer Design", Pearson India, 2017	
4.	Anand Kumar, "Fundamentals of Digital Circuits", PHI Learning Pvt. Ltd, 2009	
5.	Ashok B. Mehta, "Introduction to SystemVerilog", Pearson Education, 2006	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	APPLIED PHYSICS	**3**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	To learn atomic and molecular physics and explain the macro physical phenomenon with it
2.	To learn to interpret and model physical phenomena using calculus
3.	To learn electrostatics

UNIT	TITLE	PERIODS
1	**Electrostatics**	**12**

Charges, laws of electrostatics - Coulomb's law, Gauss's law, the electric field/force of a point charge (positive and negative), integrating along an electric line of force to get voltage, line of charge, plate of charge, relating to energy stored in a charge of a capacitor. Deriving the same with Gauss law.

UNIT	TITLE	PERIODS
2	**Vibrations and waves**	**12**

Mechanical vibrations and waves; simple harmonic motion, superposition, forced vibrations and resonance, coupled oscillations, and normal modes; vibrations of continuous systems. Visual understanding of the differential equation solution through graphs.

UNIT	TITLE	PERIODS
3	**Electromagnetism, electrodynamics**	**18**

Electric currents, magnetic fields, and Ampere's law. Magnetic materials. Time-varying fields and Faraday's law of induction. Electromagnetic waves and Maxwell's equations. Subject taught using the TEAL (Technology Enabled Active Learning) studio format which utilizes small group interaction and current technology to help students develop intuition about, and conceptual models of, physical phenomena. Understanding inductors and transformers.

UNIT	TITLE	PERIODS
4	**Semiconductor Physics**	**12**

Intrinsic semiconductor, Work Function, Carrier concentration and dependence on temperature, p-n doped semiconductor, p-n junction.		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	understand atomic and molecular physics and explain the macro physical phenomenon with it	
CO2:	interpret and model physical phenomena using calculus	
CO3:	understand electrostatics and what voltage is	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	The Aha Guide to Atoms - Balaji Sampath	
2.	8.02 Electricity and Magnetism at MIT https://web.mit.edu/8.02t/www/802TEAL3D/visualizations/coursenotes/index.htm by Dr. Sen-ben Liao, Dr. Peter Dourmashkin, and Professor John W. Belcher	
3.	Physics 102 - Electric Charges and Fields https://www.coursera.org/learn/physics-102-electric-charges fields/home/welcome	
4.	Donald A. Neamen, “Semiconductor Physics and Devices", McGraw-Hill Education, 2006.	
5.	Halliday and Resnick, “Principles of Physics, Extended, 12ed (An Indian Adaptation)”, 2023	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC INDIAN LANGUAGE(HINDI)	**3**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	To introduce the students to Hindi Alphabet and To encourage the students to speak Hindi
2.	To enable students to use Hindi in day-to-day communication
3.	To build up their confidence in the usage of Hindi
4.	To expose them to light poetry
5.	To introduce them to the basics of tenses

UNIT	TITLE	PERIODS
1	**Hindi script and sound system**	**11**

Vowels-Consonants: Vocal Tract-Consonants: Voicing & Aspiration-Hindi Consonants 1- Hindī Consonants 2-Alphabetic Order and Transliteration Conventions for Devanagari

UNIT	TITLE	PERIODS
2	**Introduction to basic structures**	**11**

Identifying and writing Hindi phrases and sentences - questions based on translating sentences from English.

UNIT	TITLE	PERIODS
3	**Grammar**	**11**

Tenses-types of Tenses

UNIT	TITLE	PERIODS
4	**Poetry**	**11**

Meri Rail - Chiriyon Ke The Bache Chaar- Titli Rani Bari Sayani - Chuk Chuk karti Railgari - Aao Ham Sab Jhula Jhoolen - Ek Baar Phir Se jai Bolo

UNIT	TITLE	PERIODS
5	**Functional Hindi**	**10**

Identify and use conjuncts in names and house objects - use of singular/plural, masculine/feminine	
TOTAL PERIODS	**54**
COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Identify the Hindi alphabet.
CO2:	Write and speak Hindi words and phrases.
CO3:	Express their basic needs and interact with others
CO4:	Speak and express their ideas in Hindi
CO5:	Be exposed to poetry
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Rupert Snell, "Complete Hindi"; 1st Edition, Teach Yourself, 2014.
2.	Richard Delacy and Sudha Joshi,"Elementary Hindi";Tuttle Publishing,2014.
3.	https://wp.nyu.edu/virtualhindi/house/
4.	http://hindistartalk.lrc.columbia.edu/lesson/rathore-family-introduction/
5.	http://hindistartalk.lrc.columbia.edu/lesson/rajawat-family-introduction/ (0.00 - 1.05)
6.	http://www.learning-hindi.com/post/1156594856/lesson-51-possessive-pronouns-part-3-%E0%A4%95-kaa
7.	http://www.learning-hindi.com/post/6324812777/lesson-115-%E0%A4%AD-bhee-too-also
8.	http://hindistartalk.lrc.columbia.edu/lesson/rathore-family-our-home/
9.	http://www.learning-hindi.com/post/880500641/lesson-19-numbers-11-20

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	CIRCUITS & SIMULATION LAB	**1**	**0**	**4**	**3**

PREREQUISITES:

Basic Electronics
Basic Electronics Lab

COURSE OBJECTIVES:

1.	Have a deeper understand of the limitations of lab equipment and simulations
2.	Deeper understanding of component non-ideality
3.	Ability to implement solutions to more complicated circuit requirements
4.	and troubleshoot more complex electronic circuits
5.	design projects of greater complexity using electronics.

UNIT	TITLE	PERIODS
1	**Introduction & DC Analysis**	**15**

concept of a netlist, schematic ←→ netlist conversion, Circuit simulators, DC Bias/Operating point (stimulus, node voltages, branch currents, device states), Parameters in computing DC bias point (Supply, Temperature, process, circuit parameters), parameter sweep. Simulation tolerances (reltol, iabstol, vabstol, gmin) - what they mean, speed accuracy tradeoffs, how to use them, Convergence issues.

UNIT	TITLE	PERIODS
2	**Transient Analysis**	**15**

Concept of time varying signal, Slow moving stimulus as Time dependent DC sweep, concept of memory and circuit state, time step (fixed vs variable), convergence methods - gear/trapezoidal

LABORATORY	**60**

RESISTOR NETWORKS

1. Measurement of 9V Battery internal resistance
2. Measurement of Wall supply internal resistance
3. Resistance of R-2R and R-R ladder and verification via DC simulations
4. Estimate power rating of 10Ohm/1K/100 Ohm resistors.

5. Lab Challenge1: Estimating Voltmeter internal resistance, Ammeter internal resistance and measurement error based on previous 2 measurements.
6. Lab Challenge2: Create a resistor as close to sqrt(2) as possible, test it and simulate it.
7. Lab project: Temperature sensing with Thermistor. Testing with heat Gun and thermometer.

ACTIVE & OPAMP R CIRCUITS: All circuits to be simulated and bench tested

1. Estimating Op-amp parameters (Zin, Zout, Voff, Adc)
2. Zener diode based regulation
3. Schmitt trigger
4. Lab Challenge 1 - Given 3 voltage inputs, create a circuit where the LED glow indicates the maximum supply and minimum supply
5. Lab Challenge 2: Create an Op-amp(s) circuit with a single power supply and three LEDs where each LED glow indicates the voltage zone (input voltage divided into 3 zones)
6. Lab Challenge 3: Convert an input sine wave into a square wave with 20% duty cycle given the input amplitude and offset.
7. LDR based photodetector with only BJTs and resistors (no comparator or Op-amp)
8. Lab Project - Temp Sensor with diode and op-amp

ACTIVE RC CIRCUITS: All Circuits are to be simulated and bench tested

1. Op-amp RC based Astable vibrator with a given frequency and duty cycle.
2. Lab Challenge 1 - Given an input square wave of a given frequency, create another square wave with a given phase delay,
3. Lab Challenge 2: Given an input square wave, create a sawtooth wave of a given amplitude
4. Lab Challenge 3: Given and input square wave, create a triangle wave of given amplitude

Lab Project - Given a triangle wave, create a sine wave using filtering.

TOTAL PERIODS	**90**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Have a deeper understand of the limitations of lab equipment and simulations
CO2:	Deeper understanding of component non-ideality
CO3:	Ability to implement solutions to more complicated circuit requirements
CO4:	and troubleshoot more complex electronic circuits
CO5:	design projects of greater complexity using electronics.

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION

1.	Paul Horowitz and Winfield Hill, “The Art of Electronics”, Cambridge University Press, 2015.
2.	Yannis P. Tsividis, “A First Lab in Circuits and Electronics” , Oxford University Press, 2018.
3.	Charles Platt, “Encyclopedia of Electronic Components Volume 1”, O'Reilly Media, Incorporated, 2012.
4.	W. H. Dennis, “Electronic Components and Systems”, Elsevier Science, 2013.
5.	Sean Westcott, Jean Riescher Westcott, “Basic Electronics Theory and Practice”, Mercury Learning and Information, 2020.

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	DIGITAL LOGIC DESIGN LAB	**0**	**0**	**6**	**3**

PREREQUISITES:

Introduction to Programming
ESP32 Programming in Python
Digital gates and IC layout
Basic Digital Gates Lab

COURSE OBJECTIVES:

1.	Introduction to hardware description Languages
2.	Writing synthesizable code
3.	Implementing digital circuits upto mid-level complexity
4.	Debugging models
5.	Introduction to waveform Viewer tools

UNIT	TITLE	PERIODS
	LABORATORY	**108**

Combinational Logic

1. Behavior modeling and Basic Logic gates in verilog - NOT, NAND, NOR, AND, OR.
2. Implementing MUX, Decoder and Encoder via Behavioral and structural modeling
3. Implement Half adder and Full Adder circuit via behavioral modeling and structural modeling
4. Implement any random 5-variable Boolean function via behavioral, structural and tabular modeling and using always@(*) constructs
5. Implement the CD4028 BCD to decimal decoder

Sequential circuit modeling

1. Implement Behavioral models of SR, JK and D latches
2. Implement Behavioral models of SR/JK/D_Flip Flops
3. Implement a Shift register with 5 D-Flip Flops in series using only Blocking assignments in one instance and non-blocking in the other
4. Model a 5-bit binary counter with and without the reset input

Commercial Digital IC modeling

1. Implement a model of the CD4017 Counter
2. Implement a model of the CD4033 counter
3. Implement a model of the 74LS161 Counter
4. Implement a model of the CD4014B Shift register

Modeling Digital Circuits with Mid-level complexity

1. Implement a model of a deglitcher that deglitches the rising edge with a fixed delay,both edges with the same delay and both edges with differet delays
2. Implement a deglitcher model that deglitches a rising delay with an input controlleddelay
3. Implement a pulse extension circuit, extending just one edge, extending both edges tothe same fixed extent and extending both edges to different extents
4. Implement a pulse extension circuit that extends one edge to an extent that is input controlled
5. Implement a pulse extention function combining a deglitcher function

Memory and advanced digital modeling

1. Model a 128 bit ROM with given input functionality
2. Model a 256 bit RAM with a given input functionality
3. Model a Finite state machine with given features
4. Model an ALU with the given function
5. Model a PLA with given features

TOTAL PERIODS	**108**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Write code describing digital functionality with mid-level complexity
CO2:	Write code that can be synthesized into a digital circuit.
CO3:	Debug Digital models with mid-level complexity
CO4:	Use waveform viewer tools effectively

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION

1.	Samir Palnitkar, " Verilog HDL : A Guide to Digital Design and Synthesis",Pearson Education, 2003.
2.	Brian Holdsworth, Clive Woods , "Digital Logic Design", Elsevier Science,2002.
3.	M. Morris Mano, "Digital Logic and Computer Design", Pearson India, 2017.
4.	Debashis De, "Digital Design Using Verilog: A Simplified Approach, PHIlearning pvt ltd, 2013
5.	A.P. Godse and D.A. Godse, "Sequential Logic: Analysis and Synthesis",Technical Publications, 2008

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	MICROCONTROLLER THEORY AND LAB (THEORY AND PRACTICE)	**2**	**0**	**4**	**4**

PREREQUISITES:

Introduction to programming
ESP32 Programming in Python

COURSE OBJECTIVES:

1.	Introduce the students to microcontrollers, how they work, their features and their abilities
2.	Introduce students to General purpose electronic systems such as ADCs, DACs, Sensors, Timers, Clocks, Memory
3.	Introduce students to communication protocols

UNIT	TITLE	PERIODS
1	**Introduction and Simple Peripherals**	**12**

Microcontroller - functions, capabilities, components, features, architecture. Microcontroller components - Processor, Clocks, Timers, I/O pins, Memory, ADC, DAC, communication peripherals. Brief description of all components. I/O pins - assignment, configurations, classification, functions, speed, addressing, R/W. ADC - function, capabilities, metrics, number of bits, resolution, LSB/MSB, speed/clock rate, sampling, successive approximation. Brief

UNIT	TITLE	PERIODS
2	**Communication Protocols**	**12**

Communication protocols - function, master/slave concept, start/stop conditions, clock and data lines, how slave is selected, register addressing for R/W, data R/W. The I2C protocol - 2 line interface, SDA/SCL, ACK/NACK, command format, testing. The SPI protocol - 4 line interface, CS/MISO/MOSI/CLK, command format and testing. USART – Lines

UNIT	TITLE	PERIODS
3	**Clock, Timers and Interrupts**	**12**

Real Time Clock - internal clocks, reference clock, power. Timers - function, input capture, Output compare. Interrupts - Function, purpose, enabling, External, Timer driven (internal interrupt), priority.

LABORATORY	72

I/O Manipulation: Depending on which of two push buttons is pushed and released, blink or ramp an LED. The period should be externally controllable via a potentiometer input to a GPIO pin that accepts analog inputs

1. Potentiometer review: Given an input voltage, tweak the potentiometer manually to obtain the desired output voltage
2. PWM controller: Control the duty cycle and freqency of the PWM output pins via two separate variables
3. LED Blink: Connect the PWM output pin to an LED and observe the correlation between brightness and duty cycle
4. LED Ramp: For a given frequency, ramp the PWM duty cycle by ramping the control variable
5. GPIO input: Given an analog input to a GPIO pin that accepts analog inputs, read out the value of that analog input on the Serial monitor
6. Push button input: Detect that a button has been pushed via a printout to the serial monitor. Mention which of the two buttons was pushed
7. Put parts 1-6 together to complete the project

COMMUNICATION PROTOCOLS AND EXTERNAL INTERRUPTS: Read accelerometer data continuously from an accelerometer module and write it to a computer screen. Implement an external interrupt via a push buttons to start and stop reading the accelerometer data.

1. Review item 6. From the previous project
2. XL readout: Continuously read XL data to a serial monitor
3. Put 1 and 2 together to complete this project
4. Repeat for SPI, I2C and USART protocols

TIMERS AND INTERNAL INTERRUPTS

Extending the previous problem, whenever the accelerometer reading exceeds a given threshold, generate an interrupt and use timers to blink an LED for a fixed number of times and then stop.

1. Review XL readout from previous section
2. LED Blink: Connect GPIO output to LED and blink an LED once for 50ms every time XL reading crosses a threshold
3. Interrupt - I: Generate an interrupt based on Pushbutton. While the push button remains pushed, replace the XL readout with the message, “XL Out disabled”
4. Interrupt – II: Whenever a pushbutton switch is pushed, replace the XL readout with “XL Out disabled” message for 10 seconds
5. Integrate 1-4 to complete the project

TOTAL PERIODS	108

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Able to program a microcontroller to do some simple tasks such as blinking LEDs, raising alarms, reading sensor data, communicating with other chips
CO2:	Able to read sensor/microcontroller data sheets and access relevant information regarding using those parts
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Julio Sanchez, Maria P. Canton , "Microcontroller Programming", CRC Press, 2018
2.	Raj Kamal , "Microcontrollers: Architecture, Programming, Interfacing and System Design: 2nd Edition", Dorling Kindersley , 2011.
3.	Uyless D. Black, "Communication Protocols and Standards", Pearson Education, 2002.
4.	Behrouz A. Forouzan, "Data Communications and Networking", McGraw Hill Education, 2014
5.	James K. Peckol, "Embedded Systems: A Contemporary Design Tool", Wiley India Pvt. Ltd, 2016

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	Electronic Drafting, Tracing & Debug	**1**	**0**	**4**	**3**

PREREQUISITES:

Basic Electronics
Basic Electronics Lab
PCB Design and EDA Lab

COURSE OBJECTIVES:

1.	Introduce the students to the functioning of some common everyday appliances and lab equipment
2.	Introduce students to General principles in appliance and instrument malfunction diagnosis
3.	Introduce students to some common easily fixed problems in everyday appliances and instruments

UNIT	TITLE	PERIODS
1	**General Principles in Appliance Debug**	**18**

AC mains – 60 Hz, 230V RMS, 3-wire socket, Phase neutral, earth, Earthing concept, testing and debug of AC mains. Opening up an Appliance and location the common parts - Transformers, Fuses, Bridge rectifier, Regulator, looking for Rusted components, burnt out or leaky components, burnt out or broken PCB traces, broken wire connections, performing connectivity tests, testing BJTs, testing diodes, tracing the power supply AC to DC path,

LABORATORY	**144**

1. LED Lamp Repair
2. Battery Charger Repair
3. Induction stove repair
4. Table Fan repair
5. Soldering Iron repair
6. Regulated power supply repair
7. Voltage Stabilizer Repair
8. Mobile Phone Charger repair

TOTAL PERIODS	**162**

COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Able to repair some commonly occurring problems in most household appliances
CO2:	Able to diagnose the location of some commonly
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Douglas Kinney, “A beginners guide to consumer Electronics repair: Handbook and tutorial”
2.	Homer L. Davidson, “Electronic Troubleshooting and Repair handbook”, McGraw-Hill Education, 1999.
3.	Raj Kamal, “Embedded Systems: Architecture, Programming and Design", McGraw Hill Education, 2008
4.	Robert Pease, “Troubleshooting Analog Circuits”, Newnes, 1991.
5.	David J. Agans¸ “Debugging: The 9 Indispensable Rules for Finding Even the Most Elusive Software and Hardware Problems”, Amacom, 2002.

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	INTEGRAL YOGA & VALUE EMBODIED LEADERSHIP I - REFRESHER	**1**	**0**	**4**	**3**

PREREQUISITES:

Integral Yoga & Value Embodied Leadership - I

COURSE OBJECTIVES:

1.	To understand and develop a consciousness-centered worldview
2.	To demonstrate the major conception of Integral Yoga and the triple movements
3.	To learn Radical Transformational Leadership tools to apply what I stand for (care about) in my everyday practice.
4.	To learn systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment.
5.	To learn distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

UNIT	TITLE	PERIODS
1	**Consciousness-centered worldview**	**6**

Consciousness-meaning & concepts; Broad regions of Consciousness; Evolution & Involution.

UNIT	TITLE	PERIODS
2	**Integral Yoga: An Adventure of Consciousness**	**6**

Integrality; Physical, vital and mental consciousness; The psychic being; Mental evolution; Liberation and Transformation

UNIT	TITLE	PERIODS
3	**The Triple Movements**	**6**

Aspiration, Rejection and Surrender

LABORATORY	**72**

1. Integrity (being whole and undiminished) 2 Reviewing my BTI- CSFR and Respond & Realize 3. Judgment & Discernment 4. Synergistic Operational Strategies - Part 1(understanding) 5. Synergistic Operational Strategies - Part 1 - Reviewing my BTI 6. Guilt the hidden payoff 7. Three domains of my Listening and speaking 8. Synergistic Operational Strategies - Part 2 9. Likert Emberling – Stages of leadership 10 Overload and Overwhelm 11. Conversations for action - committed requests, committed responses. 12. Principled Outrage distinguished from Destructive Anger 13 Transformational Results Chain (understanding) 14. Transformational Results Chain and My project: Individual work	
TOTAL PERIODS	**90**
COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Understand and develop a consciousness-centered worldview
CO2:	Explain the major conception of Integral Yoga and the triple movements
CO3:	Practice Radical Transformational Leadership tools to apply what I stand for (care about) in my everyday life.
CO4:	Apply systems thinking and design projects for cultural and systemic shifts and technical solutions in alignment.
CO5:	Have the granularity to choose to transcend emotions and fears and work out of their full potential
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	https://www.ipi.org.in/infinity/infinityfiles/0-2-2-integrality.php
2.	Sri Aurobindo," Life Divine & Synthesis of Yoga", Shri Aurobindo Ashram Publications, 1921.
3.	Monica Sharma, "Radical Transformational Leadership: Strategic Action for Change", North Atlantic Book Publications,2017.
4.	Sri Aurobindo, "The synthesis of Yoga", Sri Aurobindo Ashram Publication Department, 2010
5.	Sri Aurobindo, "Integral Yoga", Lotus Press, 2015

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC ANALOG CIRCUITS – OPERATION & LAYOUT	**4**	**0**	**0**	**4**

PREREQUISITES:

Basic Circuit Theory
Circuits & Simulation Lab
IC Layout - Digital Lab (Theory and Practice)
Digital Gates and IC Layout
PCB Design and EDA Lab

COURSE OBJECTIVES:

1.	Understand the manufacturing process as it pertains to Analog Layout
2.	Understand the various layers as they pertain to various devices and interconnects
3.	Understand constraints and tradeoffs involved in the various aspects of Analog Layout
4.	Understand the various steps in Analog layout - Floorplanning, routing, supply ground meshing and the interdependence between them
5.	Understand the iterative nature of Analog Layout
6.	Understand the function and modeling of some simple analog electronic components
7.	Understand incremental modeling of analog circuits and the application of calculus therein

UNIT	TITLE	PERIODS
1	**Mos Transistor – Operation, Fabrication & Layout**	**8**

introduction – terminals, symbol, direction of current flow, mos transistor as a switch. Parameters – Width, length, Threshold voltage, mobility, Gate capacitance, Gamma, lambda. Operational modes – Cutoff, Triode, Saturation, accumulation. Geometry – shape, dimensions, cross section. Layout Fabrication and manufacturing process, ESD, Latchup, WPE, LOD, STI, Antenna effects

UNIT	TITLE	PERIODS

2	**Matching in Analog Circuits - Floorplanning**	**16**
Current Mirrors - functionality & mismatch, causes of mismatch - process and temperature gradients, orientation, WPE/LOD, environment. Mismatch reduction techniques - Interdigitation, common centroid, dummies, well placement, matching the environment, matching huge cells - the unit cell concept, the dispersion concept. Differential pair matching – The half cell concept, Resistor matching, Capacitor matching. Principles of floorplanning - Symmetry, modularity, regularity etc.		
UNIT	**TITLE**	**PERIODS**
3	**Routing – Signals and Power/Ground**	**16**
The concept of standard routing – unit cell concept, The concept of symmetrical routing – the half cell concept, interconnect modeling, coupling capacitance, principles of routing high impedance nodes, principles in routing Sensitive signals, conduits, shielding, IR Drops, principles of routing branches carrying huge currents, Electromigration and Joule heating, temperature effects, effects of asymmetric routing on matching. Concept of Meshes, relation of meshes to ground planes, meshing and routing, principles of meshing, ground/supply planes interplay. Supply capacitor (deCap) placement and routing		
UNIT	**TITLE**	**PERIODS**
4	**Inductors And RL/LC Circuits**	**20**
Inductor as a storage element - magnetic flux, I-V relationship, energy, Series and parallel combination, Inductor circuits with DC Voltage sources and switch combinations. RL circuits – introduction, Step response, RL delays and time constant, comparison with RC circuits, Inductor as a dual/complement of a capacitor LC circuits – KCL equations, solution to differential equation, oscillations, initial conditions, tank concept, Loss and damping, damping time constant, LCR circuits		
UNIT	**TITLE**	**PERIODS**
5	**Analog Electronic Components**	**12**
Comparator function – Offset and hysteresis, Amplifier function - gain, offset, saturation, single ended input, differential input and single ended output. Differential amplifier - output common mode. Amplifier time constants - step response		
	TOTAL PERIODS	**72**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Layout an analog circuit given the constraints (matching, sensitive signals, power routes etc)	
CO2:	Translate circuit constraints translate to physical layout	
CO3:	Model simple analog functions	

CO4:	Model continuous time functions using a discrete time simulator
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Ray Alan Hastings, " The Art of Analog Layout", Pearson Prentice Hall, 2006.
2.	Ricardo M. F. Martins, " Generating Analog IC Layouts with LAYGEN II", Springer Berlin Heidelberg, 2013.
3.	Dan Clein, "CMOS IC Layout Concepts, Methodologies, and Tools", Elsevier Science, 1999.
4.	C. A. Desoer, E. S. Kuh, "RL Circuits and Time Domain Analysis of Linear Circuits", MIT Press, 1969.
5.	Clayton R. Paul, "Introduction to Electromagnetic Compatibility", Wiley-IEEE Press, 2006

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	FOREIGN LANGUAGE (GERMAN)	**3**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	Students should become familiar with the German language; the 4 language skills are: listening, speaking, reading and writing.
2.	To empower the students to use German in daily communication.
3.	To build up their confidence in the usage of German.
4.	Familiarize the students with social, economic and cultural life in Germany.

UNIT	TITLE	PERIODS
1	**Hello And Basics**	**10**

Language acts: greet and say goodbye/introduce oneself and others/talk about oneself and others/name numbers up to 20, telephone number and e-mail address/spell them/talk about countries and languages. Vocabulary: numbers from 1-20/countries and languages. Grammar: question/statement/verbs and personal pronouns. Pronunciation: alphabet. Regional studies: Countries and languages. Film: Good afternoon/The telephone number/I speak. Deepening: Advantages of learning German.

UNIT	TITLE	PERIODS
2	**Friends Colleagues And Me**	**11**

Language acts: talk about hobbies/date/name days of the week/talk about work, professions and working hours/name numbers from 20 onwards/talk about seasons/create a profile on the internet. Vocabulary: hobbies/weekdays/numbers from 20/occupations/months and seasons. Grammar: articles/verbs and personal pronouns II/yes/no questions/plural of nouns/the verbs ‘have’ and ‘be’. Pronunciation: sentence melody, questions and answers. Regional studies: Seasons and typical hobbies. Film: The trainee. Deepening: Principles of living together.

UNIT	TITLE	PERIODS
3	**In The City**	**11**

Language acts: Naming places and buildings/asking questions about places/assigning texts to a picture story/asking about things/naming means of transport/asking for directions and describing a route/understanding texts with international words/learning articles. Vocabulary: places and buildings/means of transport/directions. Grammar: definite, indefinite and negative article/imperative with 'Sie/you'. Pronunciation: long and short vowels. Regional studies: Sights, numbers, events in Hamburg. Film: Taxi ride/in the Hotel. Motivation: vision, goal setting.		
UNIT	**TITLE**	**PERIODS**
4	**Enjoy Your Meal**	**11**
Language acts: talking about food/planning a purchase/conversing while shopping/conversing while eating/understanding texts with W-questions/ordering and learning words. Vocabulary: meals/food/drinks/shops. Grammar: positions in a sentence/accusative/verb with accusative case. Pronunciation: Umlauts ä, ö, ü. Regional studies: Food in D-A-CH, professions related to food. Film: Breakfast/shopping. Motivation: plan progress		
UNIT	**TITLE**	**PERIODS**
5	**Day By Day & Time With Friends**	**11**
Language acts: understanding and telling the time/talking about the family/arranging an appointment/excusing oneself for being late/arranging an appointment by phone. Vocabulary: daily routine/time/family. Grammar: telling time with 'am, um, von…bis'/possessive article/modal verbs. Pronunciation: Hearing and speaking 'r'. Regional studies: Punctuality in D-A-CH. Film: You never have time! Motivation: Progress diary. Language acts: planning something together/talking about birthdays/understanding and writing an invitation/ordering and playing at a restaurant/talking about an event/finding specific information in texts/understanding event tips on the radio. Vocabulary: leisure activities/food/drinks/properties/events. Grammar: dates 'on..'/separable verbs/prepositions for + accusative/personal pronouns in accusative. Pronunciation: ei, eu, au. Regional studies: Pubs & Co. in D-A-CH. Film: Work? In the restaurant. Surprise! Deepening: Diversity of living together. Summarize course experiences. Write a short report.		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Communicate in a simple way in German	
CO2:	Understand and use part of the basis of German grammar	
CO3:	Understand the social and cultural life in Germany in a rudimentary way, reflect on it comparatively also with others and exchange mails about it	
CO4:	Orientate themselves in the country and in the public sphere	
CO5:	Focus on own motivation and set goals	

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Klett Verlag,"Netzwerk, Deutsch als Fremdsprache A1.1, A1.2, Kursbuch plus Audio CD, workbook", Intensive trainer,2016
2.	Dictionary German-English, App 2018.
3.	Lingolia Deutsche Grammatik, App 2018.
4.	Stefanie Dengler, "Netzwerk A1: Deutsch als Fremdsprache", Klett Verlag, 2016
5.	Klett Verlag, "Schritte International 1: Kursbuch + Arbeitsbuch", Hueber Verlag, 2006

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	FOREIGN LANGUAGE (FRENCH)	**3**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	Students should become familiar with the French language; the 4 language skills are:listening, speaking, reading and writing.
2.	To empower the students to use French in daily communication.
3.	To build up their confidence in the usage of French.

UNIT	TITLE	PERIODS
1	**'Hello' and basics**	**10**

Language acts: greet and say goodbye/introduce oneself and others/talk about oneself and others/name numbers up to 20, spelling email or telephone numbers /talk about French speaking countries Vocabulary: numbers from 1-20/countries and languages. Grammar: personal pronouns/ verb to have and to be/ statement/ yes-no questions Pronunciation: Alphabet. Typical French sounds Regional studies: French Speaking countries. Audio-Video: meeting people, very simple dialogue Deepening: Advantages of learning French.

UNIT	TITLE	PERIODS
2	**'Family, Friends, and me'**	**11**

Language acts: talk about season/date/time/name days of the week/talk about family and friends, work, professions and working hours/name numbers from 20 onwards/talk about seasons/create a profile on the internet. Vocabulary: Season/year/month/week/time/family and friends vocabulary, numbers from 20/ occupations/months and seasons. Grammar: definite and indefinite articles/ adjectives and gender/ singular-plural of nouns/conjugation at present 1st verb group. Pronunciation: linking words in French, intonation, practice of difficult French sounds Regional studies: Seasons and most liked sport and hobbies. Audio-Video: positioning oneself with respect to others. Simple dialogue.Deepening: Family in France

UNIT	TITLE	PERIODS
3	**'In the city'**	**11**

Language acts: Naming places, roads, and buildings/asking questions about places/assigning texts to a picture story/asking about things/naming means of transport/asking for directions and describing a route/understanding texts with international words/learning articles. Vocabulary: places and buildings/means of transport/directions right/left. Grammar: possessive-demonstrative pronouns, making a comparison, Imperative, few very useful irregular verbs Pronunciation: Deepening of "in, un, on, an, .." French sounds. Regional studies: French geography. Audio-Video: Finding your way/ Taxi ride/in the Hotel.		
UNIT	**TITLE**	**PERIODS**
4	**'Enjoy your meal'**	**11**
Language acts: talking about food/planning a purchase/conversing while shopping/conversingwhile eating/understanding texts with W-questions/ordering and leaning words. Vocabulary: meals/food/drinks/shops. Grammar: past (passé compose and imparfait) and futureconjugation of the 1st verb group, different type of propositions Pronunciation: hint on the French pronunciation in the street. Shortening words Regional studies: cuisine in France, professions related to food. Audio-Video: at restaurant, at the grocery store, recipe		
UNIT	**TITLE**	**PERIODS**
5	**'Day by day' & 'Time with friends'**	**11**
Language acts: talking about friends/arranging an appointment/excusing oneself for being late/deciding with friends what to do, organizing a trip, talking about money Vocabulary: daily routine /time /friends /leisure. Grammar: modal verbs and subjunctive conjugation and finding conjugation using the Bescherelle book Pronunciation: how French spoken quick. Recognize and understand in real situation Regional studies: French culture and art Audio-Video: going in vacation, to the museum, at a concert		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Communicate in a simple way in French	
CO2:	Understand and use part of the basis of French grammar	
CO3:	Understand the social and cultural life in France in a rudimentary way, reflect on itcomparatively also with others and exchange mails about it	
CO4:	Orientate themselves in the country and in the public sphere	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Myrna Bell Rochester, "Easy French Step-by-Step",McGraw Hill,2008.	
2.	Annie Heminway, "Practice Makes Perfect: Complete French All-in-One", Premium Third Edition 3rd Edition, McGraw Hill, 2022.	
3.	Michael Oates, Larbi Oukada, "Entre Amis: An Interactive Approach", Wiley,2015	
4.	Evelyne Amon, "Vis-à-vis: Beginning French", McGraw-Hill Education, 2018	
5.	Jean-Paul Valette, "Contacts: Langue et culture française", Cengage Learning,2014.	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	APPLIED MATHEMATICS FOR ELECTRONICS - II	**3**	**0**	**0**	**3**

PREREQUISITES:

Applied Mathematics
Applied Mathematics for Electronics – I
Basic Circuit Theory

COURSE OBJECTIVES:

1.	Apply the concepts learnt in Applied Mathematics for Electronics – I to RC circuits
2.	Use RC circuits as a tool to understand frequency response
3.	Introduction to Fourier series and transforms

UNIT	TITLE	PERIODS
1	**Diff. Eqns & Laplace Transforms in Electronics**	**10**

The simplest RC circuit, Simple RC circuit response to step voltage – step response, computing step response via differential equations and via Laplace transforms, simple RC circuit response to sinusoidal stimulus – currents and voltages, concept of impedance – magnitude and phase, impedance dependence on frequency

UNIT	TITLE	PERIODS
2	**Complex Impedances & Frequency Response**	**12**

Representation of capacitive impedance as a complex number – magnitude and phase, concept of complex voltages and currents, Representation of an RC circuit using complex numbers – angle between phase of stimulus & current and relationship to angle of the RC impedance, phase between voltage across capacitor and voltage across resistor and relation to complex RC impedance. Introduction to phasors, Relation between sinusoidal stimulus and Capacitor voltage for a simple RC circuit as a function of frequency – phase and magnitude, concept of frequency response and transfer functions, plotting the frequency response of simple laplace functions

UNIT	TITLE	PERIODS
3	**Fourier Series**	**12**

Motivation, Periodic functions and their representation as sum of sinusoids, concept of fundamental and harmonics, phase, fourier series representation of periodic square waves and periodic pulses, Fourier series of common periodic functions, Effect of various mathematical operations on Fourier series – amplification, summation, integration and differentiation		
UNIT	**TITLE**	**PERIODS**
4	**Fourier Transform**	**12**
Aperiodic functions, representation of aperiodic functions as periodic functions with an infinite period, fourier series of periodic functions with an infinite period – fourier transform, fourier transform of common time limited functions, effect of mathematical operations on fourier transforms		
UNIT	**TITLE**	**PERIODS**
5	**Fourier and Laplace Transforms**	**8**
Relation between fourier and laplace transforms – similarity & differences, conversion between laplace and fourier transforms for some simple and common functions		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Apply mathematical concepts to the analysis of electronics circuits	
CO2:	Understand fourier series and transforms	
CO3:	Relate fourier and laplace transforms	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	A.N. Srivastava, Mohammad Ahmad “Integral Transforms and Fourier series”, Alpha Science International, Limited, 2012.	
2.	Phil Dyke, “An Introduction to Laplace Transforms and Fourier Series”, Springer London, 2014	
3.	M.D. Raisinghania, “Differential Equations and Their Applications", S. Chand Publishing, 2013	
4.	John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006	
5.	Ronald N. Bracewell, "The Fourier Transform and its Applications”, McGraw-Hill Education, 2000	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC ANALOG CIRCUITS - LAYOUT LAB	**0**	**0**	**6**	**3**

PREREQUISITES:

NIL

COURSE OBJECTIVES:

1.	Apply theoretical layout principles to actual layout
2.	Learn how to debug LVS and DRC errors

UNIT	TITLE	PERIODS
1	**LABORATORY**	**108**

PASSIVE CIRCUIT MATCHING

1. Resistors Matching – Ratios of 1:1, 1:2, 1:4, 1:8 & 1:10
2. Metal Capacitor matching – Same ratios as above
3. MOS Capacitor matching – Same ratios as above

CURRENT MIRROR AND DIFFERENTIAL PAIR MATCHING

1. Current mirror matching of different ratios
2. Differential pair matching with unit cell, half cell creation

COMPLEX ANALOG BLOCK MATCHING

1. Operational Amplifier Layout
2. LDO Layout

Bandgap layout

TOTAL PERIODS	**108**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Layout Analog functional blocks with intermediate level of complexity
CO2:	Debug LVS and DRC errors
CO3:	Differentiate between a good and a bad layout

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION

1.	Ray Alan Hastings, " The Art of Analog Layout", Pearson Prentice Hall, 2006.
2.	Ricardo M. F. Martins, " Generating Analog IC Layouts with LAYGEN II", Springer Berlin Heidelberg, 2013.
3.	Dan Clein, "CMOS IC Layout Concepts, Methodologies, and Tools", Elsevier Science, 1999.
4.	Adel S. Sedra, "Microelectronic Circuits: Theory and Applications", Oxford University Press, 2010
5.	Donald A. Neamen, "Microelectronics: Circuit Analysis and Design", McGraw-Hill Education, 2010.

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC ANALOG CIRCUITS – MODELING LAB	**2**	**0**	**4**	**4**

PREREQUISITES:

Basic Circuit Theory
Circuits & Simulation Lab
IC Layout - Digital Lab (Theory and Practice)
Digital Gates and IC Layout
PCB Design and EDA Lab

COURSE OBJECTIVES:

1.	Understand the modeling of some simple analog electronic components
2.	Understand the complexities of real number modeling as it pertains to currents and voltages
3.	Understand the complexities of discrete time modeling of continuous time circuits
4.	An introduction to the applications of mathematics in modeling

UNIT	TITLE	PERIODS
1	**Real Number Modeling of Simple Analog Blocks**	**18**

Verilog+wreal Introduction – the idea of a real number being associated with a net, uvm packages, concept of the wreal and real datatypes as an analogy to the wire and reg datatypes.

Simple analog component Modeling – resistor divider with ratio control, amplifier modeling - output saturation, dual/single supplies & offset, comparator – offset & hysteresis, Differential amplifier modeling - Input and output common mode, analog Level shifter modeling

UNIT	TITLE	PERIODS
2	**Incremental Real Number Modeling**	**18**

Review of a simple RC circuit, RC circuit modeling – concept of an internal clock, simulation time step, $abstime, comparison of model with LTspice simulations, Extension of the RC concept modeling to RL, LC & LCR modeling

Resistor modeling – extending the concept of real number modeling, the need for a 3 terminal model, the current terminal, comparison with symbol. Capacitor modeling, combining resistor and capacitor 3-terminal models to obtain an RC circuit and comparison with RC model above, Extension to RL and LC modeling, Modeling an LCR circuit with individual R,L,C models – the KCL block, Single pole amplifier modeling

LABORATORY	**72**

ANALOG FUNCTION MODELING

1. Introduction to verilog+wreal modeling: Model a simple resistive divider
2. Model a simple resistive divider with digital control of ratios
3. Model a single-ended I/O amplifier with a given gain and offset which saturates at certain margin from the rails
4. Model a differential I/O amplifier with a given gain, offset and output common mode which saturates at a certain margin from the rails
5. Model a comparator with a given offset and hysteresis
6. Model a level shifter with error checking of the inputs

INCREMENTAL MODELING WITH DISCRETE TIME STEPS

1. Model a given RC circuit and test with a step response. Model it as a single model as well as a combination of separate models for R and C
2. Repeat 1. but for a given RL circuit
3. Generate a sine wave of a given amplitude by modeling as an LC circuit
4. Use the sine wave generated in 3. as an input to the models in 1. and 2.
5. Model a given LCR circuit both as a single model as well as a combination of separate R,L,C and a KCL model
6. Model an amplifier with a given gain, offset, output saturation and time constant

INCREMENTAL MODELING WITH DISCRETE TIME STEPS

1. Model a given RC circuit and test with a step response. Model it as a single model as well as a combination of separate models for R and C
2. Repeat 1. but for a given RL circuit
3. Generate a sine wave of a given amplitude by modeling as an LC circuit
4. Use the sine wave generated in 3. as an input to the models in 1. and 2.
5. Model a given LCR circuit both as a single model as well as a combination of separate R,L,C and a KCL model

Model an amplifier with a given gain, offset, output saturation and time constant

TOTAL PERIODS	**108**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Model Analog functional blocks with intermediate level of complexity
CO2:	Debug modeling and syntax errors

CO3:	Differentiate between a good and a bad Model
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Donald O. Pederson, Kartikeya Mayaram, “Analog Integrated Circuits for Communication Principles, Simulation and Design”, Springer, 2013.
2.	Ashok B. Mehta, “Introduction to SystemVerilog”, Springer International Publishing, 2021
3.	Ashok B. Mehta, “ASIC/SoC Functional Design Verification - A Comprehensive Guide to Technologies and Methodologies”, Springer International Publishing, 2017.
4.	Tony Chan Carusone, "Analog Integrated Circuit Design", Wiley India Pvt. Ltd, 2012
5.	Uma Rao, “Analog Circuits: A Systems Approach", Pearson Education India, 2013

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	INTEGRAL YOGA AND VALUE EMBODIED LEADERSHIP II	**1**	**0**	**4**	**3**

PREREQUISITES:

Integral Yoga and Value Embodied Leadership – I

Integral Yoga and Value Embodied Leadership – I Refresher

Indian Culture and Universal Values - I

COURSE OBJECTIVES:

1.	To incorporate aspects of integral yoga into life with meditation and reflection
2.	To incorporate aspects of integral yoga into life with Surya namaskar
3.	To integrate Radical Transformational Leadership tools in everyday practice.
4.	To design projects for system and cultural shift from universal values
5.	To learn distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

UNIT	TITLE	PERIODS
1	**Review of the triple movement**	**9**

Aspiration, Rejection and Surrender

UNIT	TITLE	PERIODS
2	**RTL (Radical Transformational Leadership) Book Reading**	**9**

Understanding the praxis around the world around RTL

LABORATORY

UNIT	TITLE	PERIODS
1	**Meditation**	**14**

To learn and incorporate daily meditation

UNIT	TITLE	PERIODS
2	**Suryanamaskar**	**14**

To learn and incorporate Surya namaskar

UNIT	TITLE	PERIODS
3	**Reflection**	**10**
To reflect weekly on the progress made physically and mentally		
UNIT	**TITLE**	**PERIODS**
4	**Refresher and triad practice**	**18**
Reflection on the tools applied in day to day life. Conversations for clarity and refreshers.		
UNIT	**TITLE**	**PERIODS**
5	**Design and implementation of breakthrough initiative**	**16**
Refresher on design templates and design and refining the breakthrough initiative at college.		
	TOTAL PERIODS	**90**

COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Develop in meditation and reflection
CO2:	Develop physically through suryanamaskar
CO3:	Use Radical Transformational Leadership tools in everyday practice.
CO4:	Design projects for system and cultural shift from universal values
CO5:	Notice distinctions that give students granularity to choose to transcend emotions and fears and work out of their full potential

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Daniel Goleman and Richard Davidson," Altered Traits: Science Reveals How Meditation Changes Your Mind, Brain, and Body", Avery Publications, 2017
2.	Monica Sharma," Radical Transformational Leadership: Strategic Action for Change", North Atlantic books Publications, Berkeley, California,2017.
3.	Sri Aurobindo, "Integral Yoga", Lotus Press, 2015
4.	Sri Aurobindo, "The Synthesis of Yoga", Sri Aurobindo Ashram Publication Dept., 2010
5.	Ashesh Joshi, "An introduction to the integral Yoga", Ashesh Joshi, 2017

Course Code	Course Title	Periods per week			Credits
	CMOS ANALOG IC DESIGN - I	L	T	P	
		4	**0**	**0**	**4**

PREREQUISITES:

1. Basic Analog Circuits – Operation and Layout
2. Basic Analog Circuits – Modeling Lab
3. Basic Analog Circuits – Layout Lab
4. Applied Mathematics for Electronics – II

COURSE OBJECTIVES:

1.	Introduction to CMOS Circuits
2.	Introduction to small signals analysis
3.	Introduction to frequency response in Analog CMOS Circuits

UNIT	TITLE	PERIODS
1	**MOS Transistor**	**8**

Review of MOS transistor I-V characteristics, parameters and operational modes, PMOS Vs NMOS, Bias point, determining the bias point of MOSFET-R circuits, MOSFET-R-Diode circuits, Transconductance – function, solving electrical networks with transconductors and amplifiers in them. DC Sweep of input in MOSFET-R circuits

UNIT	TITLE	PERIODS
2	**Introduction to Small Signal Analysis**	**8**

Using the DC sweep to pivot to the idea of an infinitesimal stimulus around a bias point, incremental currents and voltages, small signal parameters as incremental quantities – gm, gmb & gds. MOS small signal model

UNIT	TITLE	PERIODS
3	**MOS Single Transistor Amplifiers**	**16**

CS, CG and CD amplifiers – Structure, biasing, gain, input impedance, output impedance, transimpedance, max output swing and input range. Extensions of CS/CG/CD amplifiers with cascodes, active loads and source degeneration. Gain of cascaded combinations of single transistor amplifiers

UNIT	TITLE	PERIODS

4	**Current Mirrors and Differential Pairs**	**12**
Introduction to current mirrors - channel length modulation and mismatch. Introduction to differential pairs - symmetry, Half circuit concept, Differential mode and common mode gain, output impedance, input common mode range, active and passive loading, Mismatch, frequency response, CMRR and PSRR		
UNIT	**TITLE**	**PERIODS**
5	**Frequency Response**	**10**
MOS small signal ac parameters – Cgs, Cgd, Cdb, Csb, calculation from MOS SPICE parameters, MOS small signal ac model, application of MOS small signal ac model to obtain frequency dependent gain and output impedance of CS amplifier		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Perform small signal analysis on CMOS Circuits	
CO2:	Extend small signal analysis into the frequency domain	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Behzad Razavi ”Desig of Analog CMOS Integrated Circuits”, Mc Graw Hill,2017	
2.	Márcio Cherem Schneider, Carlos Galup-Montoro , “CMOS Analog Design Using All-Region MOSFET Modeling”, Cambridge University Press, 2010	
3.	A. Anand Kumar, "Microelectronic Circuits: Theory and Applications", PHI Learning Pvt. Ltd, 2016	
4.	Johan Huijsing, “Operational Amplifiers: Theory and Design", Springer, 2013	
5.	Behzad Razavi, “Fundamentals of Microelectronics", Wiley, 2006	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	BASIC CONTROL SYSTEM PRINCIPLES	**4**	**0**	**0**	4

PREREQUISITES:

Applied Mathematics for Electronics – II
Basic Circuit Theory

COURSE OBJECTIVES:

1.	Understanding the need for feedback
2.	Getting an introductory intuitive idea of a control system
3.	Understanding linearity and linear systems
4.	Getting acquainted with the framework within which Linear control systems are analyzed

UNIT	TITLE	PERIODS
1	**Introduction**	**12**

The control problem, initial position and target, the concept of feedback, the concept of control, control law, control system, a very simple control system, open and closed loop control systems (AC w/o temp sensor),

UNIT	TITLE	PERIODS
2	**LTI Systems and Transfer functions**	**12**

Time and Frequency domains, LTI Systems, Transfer functions, Impulse functions, Convolution integral, Fourier Transform, s-domain and the Laplace integral, s plane, poles and zeros, partial fraction decomposition

UNIT	TITLE	PERIODS
3	**Block Diagrams and Bode Plots**	**12**

Block Diagrams - Arrows, blocks, control flow, nodes, paths loops, block diagram algebra. Bode plots - Introduction, constants, real and complex Poles and Zeros, LF and HF poles and zeros,

UNIT	TITLE	PERIODS

4	**Negative Feedback**	**18**
Negative feedback in Operational Amplifier applications, Closed Loop and Open loop systems - Open loop and closed loop transfer function, Feedback factor, frequency response for single pole systems. Dual pole systems - Under, over and critical damping. Negative Feedback analysis in some common circuits - source degeneration, cascode current mirrors, Wilson current mirrors.		
UNIT	**TITLE**	**PERIODS**
5	**Stability and Compensation in Amplifier**	**18**
Undesirable step responses - phase and gain margins, oscillations and instability - right half closed loop poles, Understanding compensation, dominant pole compensation in 2-stage amplifiers, miller compensation in 2 stage amplifiers - pole splitting, right half/Left Half zeros and their effects, introducing a zero.		
	TOTAL PERIODS	**72**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Appreciate the need for feedback and some tradeoffs in its use	
CO2:	Appreciate the need for a control system and the tradeoffs in designing one	
CO3:	Understand the concept of linearity and linear systems	
CO4:	Understand the framework within which linear control systems are analysed	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Brian Douglas, “The Fundamentals of Control Theory”, 2019.	
2.	Brian Douglas Youtube channel, Classical Control Theory - YouTube	
3.	Joseph Cyril Babu , ” Principles of Control Systems”, S. Chand Limited, 2006.	
4.	B. P. Lathi, “Linear Systems and Signals" Oxford University Press, 2005	
5.	Gaetano Palumbo, “Feedback Amplifiers: Theory and Design", Springer, 2016	

Course Code	Course Title	Periods per week			Credits
	SOFT SKILL DEVELOPMENT – I	L	T	P	
		3	**0**	**0**	**3**

PREREQUISITES:

English,Mathematics

COURSE OBJECTIVES:

1.	To prepare the students to write their project report
2.	Get ready to write proposals implementing their ideas
3.	To prepare them to speak in Public
4.	To make them prepare effective Presentations and Enable students in Aptitude building
5.	Enable students to use their Aptitude Knowledge effectively in decision making

UNIT	TITLE	PERIODS
1	**Report, Proposal, and Project**	**11**

Report Writing, Types, Structure, Style, and Writing of Reports (on different topics), Characteristics of Report, Categories and Types of Report, Types of Proposal, Nature, and Significance, Structure of formal Proposal, Sample Proposal, Writing Proposals on different topics, Difference between Report and Proposal, Project Writing: Essential Features, Structure, Choosing the Subject, and Writing the Project on the related subject - Using CFSR

UNIT	TITLE	PERIODS
2	**Communication Skills**	**10**

Activities related to Skills required for Engineers (Managerial Skills, Leadership Skills, and Organizational Skills). Recruitments and Interviews, Stages in Job Interview, Desirable Qualities, Reviewing the common Question Types of Interviews.

UNIT	TITLE	PERIODS
3	**Strategies for Recruitment**	**11**

Recruitments and Interviews, Stages in Job Interview, Desirable Qualities, Reviewing the Common Question Types of Interviews.

UNIT	TITLE	PERIODS
4	**Numbers and Arithmetic Basic**	**11**

Classification of Numbers, Divisibility rules –LCM/HCF, Remainders – Base System, Surds, Indices, Logarithms, Percentage, Profit and Loss, Ratio and Proportion, Approximations, Vedic Maths, Intro to DI, Comprehensive Practice Test on the Number system, Percentage and Calculation		
UNIT	**TITLE**	**PERIODS**
5	**Logic Puzzles**	**11**
Code-decoding, Analogies, Direction Test, Blood relations,Reading Comprehension Practice test-1 and test-2		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Students are trained to write the proposals and assigned projects	
CO2:	Students write Presentations on different Industrial topics	
CO3:	Improve arithmetic aptitude	
CO4:	Learn tricks to solve Aptitude questions faster thereby saving time during competitive exams	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Sanjay Kumar, Pushp Lata, ”Communication Skills”, Oxford University Press, 2012	
2.	Raymond Murphy “Essential English Grammar”, Cambridge University Press, 1998	
3.	R. K. Narayan, “Malgudi Days: A Collection of Short Stories”, Penguin Publications, 2006	
4.	Meenakshi Raman, Prakash, “Business Communication”, Oxford University Press, 2011	
5.	Aggarwal R.S ,”Quantitative Aptitude for Competitive Examinations”, S Chand Publications, 2021.	
6.	Meenakshi Raman, Sangeeta Sharma “Technical Communication Principles and Practice”, Oxford University Press, 2012.	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	CMOS ANALOG IC DESIGN - I LAB	**2**	**0**	**4**	**4**

PREREQUISITES:

1. Basic Analog Circuits – Operation and Layout
2. Basic Analog Circuits – Modeling Lab
3. Basic Analog Circuits – Layout Lab
4. Applied Mathematics for Electronics – II

COURSE OBJECTIVES:

1.	Designing single stage and differential amplifiers with a given topology and spec
2.	Understanding and making appropriate design tradeoffs
3.	Understand by experience the iterative nature of design
4.	Learning how to break up a larger problem into smaller simpler ones and re-integrating

UNIT	TITLE	PERIODS
1	**Introduction & DC Analysis**	**12**

concept of a spice netlist, schematic ←→ netlist conversion, Circuit simulators, DC Bias/Operating point (stimulus, node voltages, branch currents, device states), Parameters in computing DC bias point (Supply, Temperature, process, circuit parameters), parameter sweep. Simulation tolerances (reltol, iabstol, vabstol, gmin) - their meaning, speed accuracy tradeoffs, how to use them, Convergence issues.

UNIT	TITLE	PERIODS
2	**Transient and AC Analysis**	**24**

Transient Analysis - Concept of time varying signal, Slow moving stimulus as Time dependent DC sweep, concept of memory and circuit state, time step (fixed vs variable), convergence methods - gear/trapezoidal, response of RC circuit to sinusoids of varying frequency

AC analysis - frequency related concepts - range, step, gain, phase, bandwidth. Concept of Transfer function, Linear and Logarithmic scales, dB, Bode Plots. Small signal analysis - DC Vs AC at Low frequency of CS amplifier, frequency sweep of RC circuit and comparison with transient analysis

LABORATORY	72

SINGLE STAGE AMPLIFIER DESIGN

1. Given a CS amplifier schematic(s) with MOS transistor parameters and input bias, calculate and verify via simulations – the DC bias point, DC gain, Frequency response. Predict and verify via SPICE the response to sinusoidal inputs of a given amplitude and frequency
2. Given a CG amplifier schematic(s), calculate and verify via spice simulation – DC bias point, input impedance, transimpedance, frequency response. Predict and verify via SPICE the response to sinusoidal inputs of a given amplitude and frequency
3. Given a source follower schematic(s), calculate and verify via spice simulation – DC bias point, output impedance, gain and frequency response. Predict and verify via SPICE the response to sinusoidal inputs of a given amplitude and frequency
4. Unit Challenge: Design and simulation verification of two-stage CS-CD amplifier with given specs (Supply, power, Gain, load, settling time, output swing). Student will need to learn to break the problem into component parts and put it together.

DIFFERENTIAL PAIR DESIGN

1. Given a schematic with a differential pair and parameters of all transistors and devices in the schematic, estimate and verify via SPICE simulations – DC Bias point, DC differential gain, DC common mode gain, CMRR, output common mode voltage, input common mode range and frequency response.

Unit Challenge - Design and simulation of a Differential amplifier with given topology to meet given specs (Gain, Vdd, input impedance, power, settling time, max overshoot, Load, output swing, CMRR). Monte Carlo sims for CMRR

TOTAL PERIODS	108

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Design simple CMOS amplifiers for considerations of gain and frequency response
CO2:	Understand some of the tradeoffs in CMOS Analog design
CO3:	Understand by experience the iterative process in design
CO4:	Learning how to break up a large problem into smaller simpler ones

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION

1.	Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw-Hill, 2017.
2.	Márcio Cherem Schneider, Carlos Galup-Montoro , “CMOS Analog Design Using All-Region MOSFET Modeling”, Cambridge University Press, 2010.

3.	Meyer, Hurst, Meyer, Lewis, “Analysis and Design of Analog Integrated Circuits”, Wiley, 2009
4.	Allen, Holberg, “CMOS Analog Circuit Design”, Oxford University Press, 2011
5.	Johns, Martin, Carusone, “Analog Integrated Circuit Design”, Wiley, 2011

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	Introduction to Signals and Systems	**1**	**0**	**4**	3
PREREQUISITES:					
NIL					
COURSE OBJECTIVES:					
1.					
2.					
3.					
4.					
5.					
UNIT	**TITLE**				**PERIODS**
1					**6**
UNIT	**TITLE**				**PERIODS**
2					**6**
UNIT	**TITLE**				**PERIODS**
3					**6**
					72
	TOTAL PERIODS				**90**
COURSE OUTCOMES					

CO1:	
CO2:	
CO3:	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	

Course Code	Course Title	Periods per week			Credits
	CMOS ANALOG IC DESIGN – II	L	T	P	
		4	**0**	**0**	**4**

PREREQUISITES:

CMOS Analog IC Design – I
CMOS Analog IC Design – I Lab
Basic Control Systems Principles

COURSE OBJECTIVES:

1.	Understand the Miller effect and utilize it in stabilizing feedback loops
2.	Understand various stabilization techniques
3.	Understand non ideal second order effects in circuit design

UNIT	TITLE	PERIODS
1	**The Miller Effect in Common Source Amplifiers**	**12**

Input impedance of an unloaded common source amplifier – Effect of Gain, Cgs, Cgd, Frequency response of a common source amplifier with a gate/input resistance – Miller effect, Effect of heavy output loading on the miller effect, miller effect in two stage differential amplifier.

UNIT	TITLE	PERIODS
2	**Underdamping in Two Stage Differential Amplifiers**	**15**

Two stage Differential amplifier in unity gain/voltage follower configuration – step response, overshoot and ringing, effect of load capacitance on step response. Analysis of step response – Transfer function, zeros and poles, Bode plots, gain and phase margins, open loop and closed loop transfer functions, relationship between open loop transfer functions and closed loop step response

UNIT	TITLE	PERIODS
3	**Dominant Pole and Miller compensation**	**18**

Causes of underdamping, mathematical solutions to underdamping and their circuit equivalents, Dominant pole compensation – effect on transfer function, bandwidth, overshoot, poles, zeros disadvantages. Miller compensation – effect on open and closed loop transfer function, bandwidth, overshoot, poles, zeros. Mitigating the effect of the open loop zeros –

moving to RHP HF, removal, moving to LHP, pole-zero cancellation, effect of pole-zero cancellation error on transient.		
UNIT	**TITLE**	**PERIODS**
4	**Other Non ideal effects**	**9**
Mismatch – Pelgrom coefficients, calculation of Threshold and mobility mismatch from Pelgrom coefficients. PSRR – introduction, frequency response, causes, mitigation techniques. CMRR – introduction, causes, frequency response and mitigation techniques		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Design a stable two stage differential amplifier in CMOS technology	
CO2:	Modify existing 2-stage amplifier designs to meet changing specifications	
CO3:	Stabilize negative feedback loops in various circuits	
CO4:	Deal with Power supply noise and disturbances in various circuits	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Behzad Razavi, " Design of Analog CMOS Integrated Circuits", McGraw-Hill, 2017.	
2.	Joseph Cyril Babu , " Principles of Control Systems", S. Chand Limited, 2006.	
3.	Márcio Cherem Schneider, Carlos Galup-Montoro , "CMOS Analog Design Using All-Region MOSFET Modeling", Cambridge University Press, 2010.	
4.	Meyer, Hurst, Meyer, Lewis, "Analysis and Design of Analog Integrated Circuits", Wiley, 2009	
5.	Allen, Holberg, "CMOS Analog Circuit Design", Oxford University Press, 2011	
6.	Johns, Martin, Carusone, "Analog Integrated Circuit Design", Wiley, 2011	

Course Code	Course Title	Periods per week			Credits
	SOFT SKILL DEVELOPMENT – II	L	T	P	
		1	**2**	**0**	**3**
PREREQUISITES:					
English and Mathematics					
COURSE OBJECTIVES:					
1.	To prepare the students, think critically.				
2.	To prepare the get ready for aptitude exams				
3.	To Improve communication skills.				
4.	Develop a synthesizing mind.				
UNIT	**TITLE**				**PERIODS**
1	**Group discussions**				**10**
Advantages of group discussion, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.					
UNIT	**TITLE**				**PERIODS**
2	**Reading comprehension advanced**				**8**
A course on how to approach middle-level reading comprehension passages.					
UNIT	**TITLE**				**PERIODS**
3	**Problem solving**				**11**
Money-related problems; Mixtures; Symbol-based problems; Clocks and calendars; Simple, linear, quadratic, and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics, Time speed and distance, work time problems.					
UNIT	**TITLE**				**PERIODS**
4	**Professional grooming and practices**				**11**
Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behavior, personal hygiene, professional attire, cultural					

adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, concluding the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.		
UNIT	**TITLE**	**PERIODS**
5	**Non-verbal reasoning, simple engineering aptitude, and Spatial aptitude**	**14**
Mirror image, Water image, Paper folding, Paper cutting, Grouping of figures, Figure formation and analysis, Completion of incomplete pattern, Figure matrix, Miscellaneous, Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems, etc., related problems.		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their interpersonal and leadership skills.	
CO2:	Examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arriving at a consensus.	
CO3:	Identity, recall and arrive at appropriate strategies to solve questions on geometry. They will investigate, interpret and select suitable methods to solve questions on arithmetic, probability, and combinatorics.	
CO4:	Relate, choose, conclude and determine the usage of the right vocabulary	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	R. S. Aggarwal, S. Chand, Abijith Guha, TMH, Arun Sharma," Quantitative Aptitude ", S Chand Publications,2001	
2.	Geoffrey Leech, Jan Svartvik, "A Communicative Grammar of English", Longman Publications,London,2003.	
3.	Sanjay Kumar, Pushp Lata, "Communication Skills", Oxford University Press, 2012	
4.	Meenakshi Raman, Prakash, "Business Communication", Oxford University Press, 2011	
5.	Meenakshi Raman, Sangeeta Sharma, "Technical Communication Principles and Practice", Oxford University Press, 2012	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	IC LAYOUT - SYSTEM CONSIDERATIONS	**2**	**0**	**4**	**4**

PREREQUISITES:

Basic Analog Circuits – Operation and Layout
Basic Analog Circuits – Layout Lab

COURSE OBJECTIVES:

1.	To learn the considerations/constraints/tradeoffs involved in Chip level Layout
2.	To learn the interdependence between packaging, pin placement and Layout

UNIT	TITLE	PERIODS
1	**Pin Placement and Packaging**	**6**

Considerations in Choosing Package, EMI Considerations in Pin placement, Absolute and relative pin placement, Bond wires. Supply/ground pins - placement, multiple usage and distribution. GPIO pin placement, RF RX/TX pin placement. Absolute and relative pin placement considerations.

UNIT	TITLE	PERIODS
2	**System Floorplanning**	**15**

Considerations in system layout, Area estimation of each constituent block, considerations in Relative and absolute placement of each individual block, Deciding on the dimensions (X,Y) of the constituent blocks, Influence of NWell spacing rules, Supply/GND partitioning considerations in floorplanning, Power Devices and heat dissipation - die thermals, Temperature sensitive blocks and devices, RF sensitive devices, RF aggressors, Dummy metal blocks - Density Errors, Adding IP Blocks, Use and placement of Supply decoupling caps at top level

UNIT	TITLE	PERIODS
3	**System Routing and Power Planning**	**9**

Chip Level signal flow, Routing space/channel estimation, Critical signal considerations - shielding/parasitics/conduiting, Power routes - EM considerations and IR drops, Power/ground meshing at top Level and aligning with meshes at block level.

UNIT	TITLE	PERIODS

4	**Other Considerations and Features**	**6**
Customizing DRC rules based on prior experience, Antenna Effects, ERC checks, ESD, Pad Layout considerations, metal masking, probe pads – Dealing with and handling blocks that have them		
LABORATORY		**72**
INDIVIDUAL BLOCK LAYOUT Students will each layout an individual block from a list. Each student will layout a different block. All the blocks will be chosen so that when put together, they comprise a full system chip **SYSTEM LAYOUT** For this stage, each student will have access to the layout blocks from each of the previous students and layout the entire system as per the constraints learnt in theory.		
	TOTAL PERIODS	**108**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	To learn the considerations/constraints/tradeoffs involved in Chip level Layout	
CO2:	To learn the interdependence between packaging, pin placement and Layout	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Ray Alan Hastings, " The Art of Analog Layout", Pearson Prentice Hall, 2006.	
2.	Dan Clein, "CMOS IC Layout Concepts, Methodologies, and Tools", Elsevier Science, 1999.	
3.	Holger Graeb, "Analog Layout Synthesis: A survey of Topological Approaches", Springer, 2011	
4.	Saint, Saint, "IC Mask Design: Essential Layout techniques", McGraw-Hill Education, 2002	
5.	Kahng, Lienig, Markov, Hu, "VLSI Physical Design: From Graph partitioning to Timing Closure", Springer, 2011	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	CMOS ANALOG IC DESIGN – II LAB	**0**	**0**	**8**	**4**

PREREQUISITES:

CMOS Analog IC Design – I
CMOS Analog IC Design – II
Basic Principles of Control Systems

COURSE OBJECTIVES:

1.	Understanding and using Negative feedback in circuit design
2.	Understanding the tradeoffs involved in using feedback
3.	Compensating unstable circuits via common compensation techniques

UNIT	TITLE	PERIODS
1	**Transimpedance Amplifier with Feedback**	**60**

Design a trans-impedance amplifier with the given topology having feedback for the given specs (Transimpedance, Load, power, Supply, settling time, phase margin, gain margin)

UNIT	TITLE	PERIODS
2	**LDO Design**	**84**

Design an LDO based on a two stage amplifier in feedback for the given specs (Output loading range, Power, Supply, Load transient, PSRR, Accuracy, settling time, Line transient, load regulation). Student has to decide whether to go with Dominant pole compensation or Miller compensation

TOTAL PERIODS	**24**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Understand and use negative feedback in circuit design
CO2:	Understand some tradeoffs involved in using feedback
CO3:	Understand by experience the iterative process in design

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Behzad Razavi, " Design of Analog CMOS Integrated Circuits", McGraw-Hill, 2017.
2.	Joseph Cyril Babu , " Principles of Control Systems", S. Chand Limited, 2006
3.	Márcio Cherem Schneider, Carlos Galup-Montoro , "CMOS Analog Design Using All-Region MOSFET Modeling", Cambridge University Press, 2010
4.	Meyer, Hurst, Meyer, Lewis, "Analysis and Design of Analog Integrated Circuits", Wiley, 2009
5.	Allen, Holberg, "CMOS Analog Circuit Design", Oxford University Press, 2011
6.	Johns, Martin, Carusone, "Analog Integrated Circuit Design", Wiley, 2011

Course Code	Course Title	Periods per week			Credits
	INDIAN CULTURE AND UNIVERSAL VALUES - II	L	T	P	
		1	**0**	**4**	**3**

PREREQUISITES:

Indian Culture and Universal Values - I

COURSE OBJECTIVES:

1.	To understand culture and learn how to know the core of a culture
2.	To analyze one's relationship with region and rituals celebrated in India
3.	To familiarize with Indian Mythology and learn to embody a universal value in it
4.	To introduce Indian architecture through temples, its essence and its appreciation

UNIT	TITLE	PERIODS
1	**Indian Culture through the exploration of Tamil Culture**	**5**

People, food, clothes; Art, music, literature, architecture, sculpture, philosophy, religion and science; Customs, traditions, and festivals

UNIT	TITLE	PERIODS
2	**Religions in India: Exploration through Godheads & Festivals**	**5**

Origin and meaning behind Indian festivals and rituals; Worshipping the Godheads; Essence of different religions and the purpose of all religions;

UNIT	TITLE	PERIODS
3	**Indian Cultural Symbols: Clothing & Attire**	**4**

Origin; Diversity of Indian clothing and significance; Conscious clothing

UNIT	TITLE	PERIODS
4	**Indian Cultural Symbols: Food & Well-being**	**4**

Conception of food and eating and cooking in India; healthy and unhealthy food and food habits; Cultural practices for well-being

LABORATORY	**72**

1.Enacting Stories from Mahabharatha and Ramayana; 2.Embodying Values: a project 3. Visit an ancient architecturally rich temple; 4. IKS (Indic Knowledge Systems) Science and art behind temples; 5.Demonstration of Indian art and architecture-appreciation of art 6. Create projects about food and eating and cooking in India; 7. Create projects on healthy and unhealthy food and food habits; 8. Understanding cultural practices for well-being 9. Create projects about the origin and meaning behind Indian festivals and rituals; 10.Projects About Worshiping the Godheads and their significance; 11.Play on the essence of different religions and the purpose of all religions	
TOTAL PERIODS	**90**
COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Relate to Indian culture and its core principles
CO2:	Explain the root of religions and rituals and rebuild one's religious personality
CO3:	Practice universal values inspired by Indian mythology
CO4:	Appreciate Indian genius in architecture and essence of Indian art and architecture
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Sri Aurobindo, “National Value of Art “, Sri Aurobindo Ashram Publications,1922.
2.	Sri Aurobindo, “Foundations of Indian Culture”,Sri Aurobindo Ashram Publications,1953.
3.	Devdutt Pattnaik, “Indian Culture, Art and Heritage”, Pearson Publications,1996.
4.	Swami Vivekananda, “Patanjali’s Yoga Sutras”, Fingerprint publishing, 2019
5.	Sri Aurobindo, “Essays on the Gita”, Sri Aurobindo Ashram Publication department, 2003

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	INNOVATIVE AND DESIGN THINKING	**1**	**0**	**4**	**3**
PREREQUISITES:					
NIL / Course Code – Course Title / Topics					
COURSE OBJECTIVES:					
1.	To Learn how to develop an innovative design model.				
2.	To Identify, understand and discuss current, real-world issues.				
3.	To learn the best design solution among the potential solutions with its functional position probability, and combinatorics.				
4.	To learn how to utilize the technical resources and to work in actual working environments.				
5.	To understand how to write technical documents and give oral presentations related to the work completed.				
Students are advised to create or innovate a software development with the following objective: Instead of creating new software and then "selling" it to the public, innovative design is a process of identifying, pinpointing, and understanding the needs of the user or audience. What we need are new choices - new products that balance the needs of individuals and society as a whole; new ideas and new strategies that tackle the global challenges of health, poverty, and education. Each student has to identify the need for a product, synthesize, analyze, design, modify and select the best design. Project Identification - Specification Development, specification, SRS, design, development and testing. Conduct Functional Decomposition, Brainstorming of possible solutions, The student will make an oral presentation followed by a brief question and answer session. The innovative design (presentation and report) will be evaluated by an internal assessment committee. The presentation will take place during the weekly class session. Students have to make oral presentations periodically and finally submit a technical project report.					
				TOTAL PERIODS	**54**
COURSE OUTCOMES					
Upon completion of this course, students will:					
CO1:	Develop an innovative design model				

CO2:	Identity, understand and discuss current, real-world issues.
CO3:	Select the best design solution among the potential solutions with its functional position probability and combinatorics.
CO4:	Utilize the technical resources and work in an actual working environment
CO5:	Write technical documents and give oral presentations related to the work completed.
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Nigel Cross, "Design Thinking: Understanding how Designers think and work", Berg Publishers, 2011
2.	Sheena Iyengar, "The Art of Choosing", Twelve, 2010
3.	Frederick Brooks, "The Design of Design: Essays from a computer scientist", Addison-Wesley, 2010
4.	Ralph Keeney, "Value-Focused Thinking: A path to Creative decision making", Ralph Kinney
5.	Aldred, Brusaw, Oliu, "Handbook of Technical Writing", Bedford/St. Martin's, 2018

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	PHYSICS OF SEMICONDUCTOR DEVICES	**3**	**0**	**0**	**3**

PREREQUISITES:

Applied Physics
Basic Electronics
Circuit Theory

COURSE OBJECTIVES:

1.	Introduction to the Physics of semiconductors
2.	Applying Physics concepts learnt in earlier physics courses
3.	To gain a physical understanding of semiconductors devices that will be useful subsequently in layout

UNIT	TITLE	PERIODS
1	**Introduction & PN Junctions**	**18**

Semiconductors - intrinsic and extrinsic semiconductors, carriers and ions, holes and electrons, carrier concentrations, generation and recombination, doping, Poisson's equation, Einstein's relationship, Diffusion and drift, transit time. Energy bands - conduction band, valence band, Fermi level, Work Functions. PN junctions, Contact potential, built-in potential, depletion region, diode I-V characteristics.

UNIT	TITLE	PERIODS
2	**MOS Transistor**	**18**

Introduction, MOS transistor cross section and terminals, Accumulation and depletion, Inversion - weak and strong, Channel creation, Intuitive MOS transistor operation (Fluid Flow/Valve analogue), MOS as a Capacitor. MOS parameters - threshold voltage, mobility, oxide capacitance, dimensions, cross sections, body effect

TOTAL PERIODS	**36**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	Appreciate MOSFET operation in context of the underlying physics
CO2:	Gain a deeper understanding of MOSFET operation

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Yannis Tsividis, Colin McAndrew, “Operation and Modeling of the MOS Transistor”, Oxford University Press, 2011.
2.	Nandita Dasgupta, Amitava Dasgupta, “Semiconductor Devices Modelling and technology”, Phi Learning, 2014.
3.	Streetman B.G., “Solid State Electronic devices”, Pearson, 1980
4.	Jasprit Singh, “Semiconductor Devices”, Mc Graw Hill Education, 2000
5.	Neaman S., "Semiconductor Physics and Devices: Basic Principles", Mc Graw Hill Education, 2002

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	ORGANIZATIONAL BEHAVIOR	**3**	**0**	**0**	**3**

PREREQUISITES:

Fundamental knowledge of Individuals and Group Behavior.

COURSE OBJECTIVES:

1.	To develop an understanding of the individuals and groups behavior inside.
2.	To develop organizations should further enhance your skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.

UNIT	TITLE	PERIODS
1	**Focus and Purpose**	**9**

Definition, need and importance of organizational behavior – Nature and scope – Frame work – Organizational behavior models, Organization and the environmental factors. Organizational Theory, Organizational behavior modification. Misbehavior –Types

UNIT	TITLE	PERIODS
2	**Group Behavior**	**15**

Organization structure (Hierarchy, Lean, project organization), responsibilities, delegation, of authority, project planning and task allocation, management Processes,continuous improvement – Formation – Groups in organizations – Influence – Group dynamics – Interpersonal Communication. Team building - Interpersonal relations – Group decision making techniques. Meaning of conflict and its types, Conflict Redressal process

UNIT	TITLE	PERIODS
3	**Individual Behavior**	**15**

Personality – Types – Factors influencing personality – Theories. How to make friends and network (factors). Attitudes – Characteristics – Components – Formation – Measurement- Values. Perceptions – Importance – Factors influencing perception – Interpersonal perception Impression Management. Emotions and Moods in workplace

UNIT	TITLE	PERIODS
4	**Leadership and Power**	**15**

Leadership – Meaning, importance, traits, styles and Theories. Leaders Vs Managers, characteristics of a good manager, leadership by delegation of responsibilities, delegation, controlling, Motivation at work – importance, need, types and its effects on work behavior, Workshop on Motivation.		
UNIT	**TITLE**	**PERIODS**
5	**Dynamics of Organizational Behavior**	**15**
Organizational culture and climate – Factors affecting organizational climate – Importance. Change Management; continuous improvement, implementing Continuous improvement, organization of change management, the change process & Resistance to change. Entrepreneurship and start your own business, product, demand and marketing, financing, Benchmarking- TQM and Six Sigma (Overview)		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Understand Group Behavior and Individual behavior	
CO2:	Understand leadership and personality development.	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Robert Kreitner, Angelo Kinicki, "Organizational Behavior: key concepts, skills and best practices", McGraw-Hill publications, 2010.	
2.	Andrew D. Szilagyi, Marc J. Wallace, "Organizational Behavior and Performance", Goodyear Publishing Company, 1977.	
3.	R. D. Agrawal "Organization & Management", PHI 1997.	
4.	Kavita Singh, "Organizational Behavior", Vikas Publishing House, 2009	
5.	S. S. Khanka, "Organizational Behavior", S Chand Publishing, 2009	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	ADVANCED CIRCUIT MODELING	**3**	**0**	**0**	**3**

PREREQUISITES:

Basic Circuit Theory

Basic Analog Circuits – Operation and Layout

Applied Mathematics for Electronics - II

COURSE OBJECTIVES:

1.	Understanding the function of some specialty analog and digital circuits
2.	Modeling advanced functionality – Both analog and digital

UNIT	TITLE	PERIODS
1	**High Impedance Modeling**	**8**

Introduction to tri-state Buffers in Digital electronics – concept of high impedance, Two circuits driving the same digital net – error resolution, Introduction to the concept of high impedance in analog circuits, modeling high impedance in analog circuits – wrealZState, high impedance resolution in systemVerilog testbenches – wrealMax, wrealMin and wreal4State. Concept of an inout port, modeling analog Switches, modeling several blocks driving the same net

UNIT	TITLE	PERIODS
2	**Specialty Digital Block Modeling**	**8**

Deglitchers, pulse extension, clock detection module – introduction, purpose, function, parameters and modeling. Reading contents of a file into a verilog variable – readmemh and readmemb, writing the contents of a file into memory – RAM/ROM

UNIT	TITLE	PERIODS
3	**Specialty Analog Blocks**	**14**

Transformers – introduction, step-up/step-down, turns & turns ratio, coupling between inductors and modeling. Amplitude and Frequency modulation – introduction, function, carrier, signal/message, waveform mathematics and modeling. Peak detector circuit – Function, operation, discharge and modeling. Varactor – introduction, operational equations, charge conservation and modeling, Modeling an LC oscillator with a frequency control via a varactor as well as switching capacitors

UNIT	TITLE	PERIODS
4	**Analog to Digital Converter**	**12**
Analog to Digital converters – Introduction, resolution and number of bits, LSB/MSB, input range, error. Types of ADCs and their operation - Flash, pipelined and successive approximation. Modeling a flash, SAR and pipelined ADC		
UNIT	**TITLE**	**PERIODS**
5	**Frequency to Voltage Converter**	**12**
Introduction, input waveforms, sine to square wave converter, counting edges/zero crossings, detecting frequency changes, windowing and filtering, charge pump, settling time and modeling		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Model and debug more complex functionality	
CO2:	Understand more advanced circuit operation	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Samir Palnitkar, “Verilog HDL : A Guide to Digital Design and Synthesis”, Pearson Education, 2003.	
2.	Mark Meershaert, “Mathematical Modeling”, 4th Edition, 2013	
3.	Brian Holdsworth, Clive Woods , “Digital Logic Design”, Elsevier Science, 2002.	
4.	M. Morris Mano, “Digital Logic and Computer Design”, Pearson India, 2017.	
5.	Debashish De, “Digital Design Using Verilog: A Simplified Approach, PHI learning Pvt ltd, 2013	
6.	A.P. Godse and D.A. Godse, "Sequential Logic: Analysis and Synthesis", Technical Publications, 2008	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	NANOTECHNOLOGY FOR ENERGY SYSTEMS	**3**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	To learn Nano-electronics and its applications
2.	To learn about Physical Properties of Nanosystems
3.	To learn about Nanotechnology for Energy Efficient Devices
4.	To learn about Nanotechnology for Energy Storage
5.	To learn about Nanotechnology for Solar Energy Conversion

UNIT	TITLE	PERIODS
1	**Nano-electronics**	**11**

Concept of wave-matter duality, phase and group velocities, electron state in solids, uncertainty principle, operators, quantum mechanical postulates, Schrödinger's Wave Equation, free electron gas, spherical, electron in spherical potential (hydrogen atom), Hydrogen molecule, Atom by Atom arrangements , band structure formation, E-k diagram, electronic states of 2-D, 1-D, 0-D nanosystems.

UNIT	TITLE	PERIODS
2	**Physical Properties of Nanosystems**	**11**

Light absorption in Nano systems, size dependence and material dependence of absorption, band gap engineering, Fermi-level, ballistic and diffusive transport in nanosystems, coulomb blockade, resonant tunnelling, carrier separation techniques

UNIT	TITLE	PERIODS
3	**Nanotechnology for Energy Efficient Devices**	**11**

Energy efficient devices –fabrication and applications of quantum well LED as light device, – optical amplifiers, quantum well lasers, optical switch, Quantum dot luminescence materials.

UNIT	TITLE	PERIODS
4	**Nanotechnology for Energy Storage**	**10**

Nanostructured electrodes fabrication, nanotubes for energy storage, nanotechnology for electrochemical storage, Nanotechnology for conversion of solar energy to hydrogen		
UNIT	**TITLE**	**PERIODS**
5	**Nanotechnology for Solar Energy Conversion**	**11**
Challenges in energy conversion – role of nanostructures & materials – nanomaterials in solar Photovoltaic Technology: quantum well solar cell, quantum wire solar cell, quantum dot solar cell – quantum dot sensitized solar cell, photo-current calculation. Tandem structures – nanotechnology 34 for solar thermal fuels, nanotubes for solar energy harvesting, Concept of photo-electro chemical cell.		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Nano-electronics	
CO2:	Physical Properties of Nanosystems	
CO3:	Nanotechnology for Energy Efficient Devices	
CO4:	Nanotechnology for Energy Storage	
CO5:	Nanotechnology for Solar Energy Conversion	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Levine, “Quantum Chemistry”, Pearson, 2013	
2.	E.S.R. Gopal, “Statistical Mechanics and properties of matter”, Ellis Horwood, 1974	
3.	Azaroff, “Introduction to solids”, Mc-Graw Hill, 1960	
4.	Yepifanov, “Physical principles of Micro-electronics”, Mir Publishers, 1974, 1st Edition	
5.	Poole, Owens, “Introduction to Nanotechnology”, Wiley, 2003	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	PROGRAMMING FOR PROBLEM SOLVING	**3**	**0**	**0**	**3**

PREREQUISITES:

Basic Programming

COURSE OBJECTIVES:

1.	To introduce the basics of computers and information technology
2.	To educate problem solving techniques
3.	To educate problem solving techniques
4.	To practice structured programming to solve real life problems
5.	To understand File Operations concepts

UNIT	TITLE	PERIODS
1	**Introduction**	**10**

History of Computers – Block diagram of a Computer – Components of a Computer system – Classification of computers - Hardware – Software – Categories of Software –Operating System – Applications of Computers – Network Structure– Internet and its services – Intranet –Study of word processor – Preparation of worksheets - Algorithm –Pseudocode – FlowChart.

UNIT	TITLE	PERIODS
2	**C Programming Basics**	**11**

Problem formulation – Problem Solving – Introduction to ‘ C’ programming –fundamentals – structure of a ‘C’ program – compilation and linking processes – Constants,Variables – Data Types –Expressions using operators in ‘C’ – Managing Input and Output operations – Decision Making and Branching – Looping statements – solving simple scientific and statistical problems.

UNIT	TITLE	PERIODS
3	**Arrays, Strings and Functions**	**11**

Arrays – Initialization – Declaration – One-dimensional and Two-dimensional arrays. String-String operations – String Arrays. Simple programs- sorting- searching –matrix operations-Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion.

UNIT	TITLE	PERIODS
4	**Structure and Unions**	**11**
Pointers – Definition – Initialization – Pointers arithmetic – Pointers and arrays- Example Problems. Structures – need for structure data type – structure definition – Structure declaration – Structure within a structure – Union – Programs using structures and Unions – Storage classes.		
UNIT	**TITLE**	**PERIODS**
5	**Files**	**11**
operations on a file – Random access to files – command line arguments Introduction to preprocessor – Macro substitution directives – File inclusion directives – conditional compilation directives – Miscellaneous directives		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Apply problem-solving techniques like algorithms, flowchart and pseudo code on real-life problems; summarize 7 phases of the program development cycle, basic tokens of the C program, its structure, I/O functions	
CO2:	Familiar on usage of structures, pointers and its manipulation	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Ashok N Kamthane," Computer Programming", Pearson Education Publications, 2nd impression, 2008.	
2.	Balagurusamy. E, "Programming in ANSI C", Tata McGraw Hill Publications, 6th Edition, 2012.	
3.	Vikas Verma, "A book on C", Language learning Publications, 2nd edition 2012.	
4.	Knuth, "The Art of Computer programming", Addison-Wesley, 1968	
5.	Cormen, Rivest, Stein, Leiserson, "Introduction to Algorithms", MIT press, 2009	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	PRODUCT DEVELOPMENT	**3**	**0**	**0**	**3**

PREREQUISITES:

Basic Electronics

PCB Design and EDA Lab

Basic Electronics Lab

Microcontroller Theory and Lab (Theory and Practice)

COURSE OBJECTIVES:

1.	Introduction to 3D Printing
2.	Introduction to Rapid prototyping

UNIT	TITLE	PERIODS
1	**Introduction to 3D Modeling**	**9**

Introduction to and overview of various 3D printing techniques, 3D modeling software overview, introduction to 3D modeling, design considerations, 3D printing materials and selection criteria, filaments

UNIT	TITLE	PERIODS
2	**Creating 3D Printing Design**	**24**

Creating some 3D printing projects using the software – Multimeter knob, Regulated power supply dial, Key chain, guitar pick

UNIT	TITLE	PERIODS
3	**3D Printers & Printing Techniques**	**12**

3D printing Hardware – components, calibration, maintenance and troubleshooting. Printing the design created in last section

UNIT	TITLE	PERIODS
4	**Advanced Topics**	**9**

Tolerances, interlocing parts, Gear printing, printing functional tools, dual extrusion printing, multi-material prints. Printing techniques – FDM, SLA, SLS, Sanding, painting and finishing.

TOTAL PERIODS	**54**

COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Write testbenches to verify complex functional blocks
CO2:	Write checkers, interfaces, tests, tasks
CO3:	Debug advanced models
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Anil Kumar C & Abhinav, "From Idea to Reality: A comprehensive guide to 3D printing"
2.	Avikshit Saras, "3D Printing made simple … Exciting and innovative technology", 2018
3.	Ward, "3-D Modeling in Silo: The official guide", Wiley, 2010
4.	Hess, "Blender Foundations", Focal Press, 2016
5.	Vaughn, "Digital Modeling", New Riders, 2012

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	SOLAR THERMAL TECHNOLOGY	**3**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	To learn the fundamentals of Solar Radiation Geometry
2.	To know about Solar Collectors, Thermal Analysis
3.	To learn the fundamentals of Solar Thermal Energy Storage
4.	To learn Solar thermal energy systems, Economic analysis for solar thermal engineering projects
5.	To know the various application of solar systems

UNIT	TITLE	PERIODS
1	**Solar Radiation Geometry**	**11**

Solar angles; the earth and solar constant; day length; angle of incidence on tilted surface; variation of extra terrestrial radiation ;solar radiation at the earth's surface; solar radiation data; sunrise, sunset and day length; local apparent time; instruments for measuring solar radiation and sunshine; solar radiation on tilted surfaces; analysis of Indian solar radiation data and applications

UNIT	TITLE	PERIODS
2	**Solar Collectors: Thermal Analysis**	**11**

Flat plate collectors: Effective energy losses; thermal analysis; heat capacity effect; overall loss coefficient; collector efficiency factor; collector heat removal factor; efficiency off lat plate collectors; testing methods. Evacuated tube collectors: Types; thermal analysis; testing methods. Concentrating collectors: Designing and types; acceptance angle; geometric concentration ratio; optical efficiency; thermal efficiency; testing methods. Selective surfaces

UNIT	TITLE	PERIODS
3	**Solar Thermal Energy Storage**	**10**

Low, Medium and High temperature thermal energy storage. Sensible heat storage: Types of sensible heat storage; energy analysis in a liquids tratified tank; design aspects; materials for latent heat storage.
Latent heat storage: Phase change material(PCM) for latent heat storage; inorganic and organic PCM's; calculation of quantity of material required for latent heat thermal energy storage; design of a solar thermal device with the provision of thermal storage. Thermo-chemical storage: Materials; merits and demerits of thermo-chemical storage; potential of thermo-chemical storage materials for high temperature applications

UNIT	TITLE	PERIODS
4	**Solar thermal energy systems**	11

Solar water heating systems: Materials and components; Natural flow; Forced flow; applications Solar air heating systems: Description and classifications; porous and non-porous type; testing of solar air heater, applications. Solar concentrating systems: Materials for concentrators; types of concentrators, single axis and two axis tracking. Solar drying: Working principle; open sun drying; direct solar drying; indirect solar drying; Designing of solar drier; psycho metric chart; energy balance equation. Solar distillation: Working principle; thermal efficiency; various designs of solar still. Solar pond: Description; Non – convective solar pond; operational problems; other solar ponds. Solar cookers: Types of solar cookers; first figure of merit and second figure of merit. Solar energy for industrial process heat: Hot water, hot air and steam based industrial process heat systems; Solar refrigeration and air conditioning: Principle of absorption cooling; basics of absorption cooling; lithium bromide-water absorption system; vapor compression refrigeration Solar thermal power generation: Principles of solar engines; solar thermal power plants: parabolic through, central receiver, parabolic dish, compact Fresnel linear reflector technology.

UNIT	TITLE	PERIODS
5	**Economic analysis for solar thermal engineering projects**	11

Annualized cost method: annualized cost; annualized capital cost; salvage value; capital recovery factor; salvage fund factor; annualized maintenance cost; Life cycle savings: savings
per day; present worth of annual savings; present worth of cumulative savings. Payback period

TOTAL PERIODS	**54**

COURSE OUTCOMES

Upon completion of this course, students will:

CO1:	To know about Solar Radiation Geometry
CO2:	The working of Solar Collectors, Thermal Analysis
CO3:	About principles of Thermal Energy Storage
CO4:	To learn about Solar thermal energy systems
CO5:	To calculate the Economic analysis for solar thermal engineering projects

REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Solar Thermal Engineering Process, Duffle and Beckman, John Wiley & Sons, Fourth edition, 2013
2.	Solar Energy, J.S. Hsieh, Prentice Hall Inc, first edition, 1986.
3.	Applied Solar Energy, A.B. Meinel and M.B. Meinel,Addison – Wiley, Second edition, 1977
4.	Solar Energy: Fundamentals & Applications, GargHP., Prakash J, Tata Mc Graw Hill, First edition, 1997
5.	Solar Energy, S.P. Sukhatme, Tata McGraw-Hill, Third edition, 2008

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	ELECTRONIC MANUFACTURING PROCESS	**3**	**0**	**0**	**3**

PREREQUISITES:

Basic electronics

COURSE OBJECTIVES:

1.	Have a deeper understanding of classification and application of PCBs
2.	Deeper understanding of design rules for analog/digital applications
3.	To learn about Pipe, FIFOs and Shared memory

UNIT	TITLE	PERIODS
1	**PCB Evolution, Classification and Application**	**18**

Evolution and Classification of Printed Circuit Boards, Challenges in Modern PCB Design and Manufacture, PCB fabrication methodologies (SSB, DSB and multilayer board), PCB design considerations/ design rules for analog, digital and power applications, Electromagnetic interference in electronic systems and its impact.

UNIT	TITLE	PERIODS
2	**Electronic Circuit Analysis**	**18**

Analysis of electronic circuit from noise emission point of view (both conducted and radiated emission) cross talk and reflection behavior of the circuit in time domain, Thermal management of electronic devices and systems.

UNIT	TITLE	PERIODS
3	**Semiconductor Packages**	**18**

Single chip packages or modules. (SCM) Commonly used packages and advanced packages; Materials in packages, Current trends in Packaging, Multichip modules (MCM)-types; System-in package (SIP); Packaging roadmaps; Hybrid circuits. Pipe and FIFOs, Shared memory, Sockets

TOTAL PERIODS	**54**

COURSE OUTCOMES

Upon completion of this course, students will:	
CO1:	Know the classification of PCBs and their applications.
CO2:	Analyze electronic circuits from noise emission point of view.
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Walter C Bosshart, “Printed Circuit Board Design and Technology”, Tata McGraw-Hill Publishing Company Limited.
2.	Clyde F. Coombs Jr., “Printed Circuits Handbook”, Tata McGraw-Hill Companies.
3.	Harper, Bishop, “Electronic Manufacturing”, McGraw-Hill, 2017
4.	Prasad, “Surface Mount Technology”, SMTA Publishing, 2019
5.	Harper, Hull, “Electronics Assembly Fabrication”, McGraw-Hill, 2002

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	IC VERIFICATION - SYSTEMVERILOG	**3**	**0**	**0**	**3**

PREREQUISITES:

Digital Logic Design
Digital Logic Design Lab

COURSE OBJECTIVES:

1.	Introduction to systemVerilog as a modeling language
2.	Introduction to IC Verification - UVM
3.	Leverage the strength of SystemVerilog in IC Verification

UNIT	TITLE	PERIODS
1	**Introduction and Simple Models in SystemVerilog**	**12**

Review of SystemVerilog in creating testbenches, introduction to modeling in systemVerilog, systemVerilog Vs verilog+wreal for real quantities, Modeling simple digital blocks in systemVerilog – gates, combinational logic, latches, Flip Flops, counters and registers. Modeling net driven by Multiple drivers – concept of drive strength

UNIT	TITLE	PERIODS
2	**Advanced Testbench Constructs in SystemVerilog**	**9**

Advanced Systemverilog constructs for testbenches - Force and release, Final Begin, `ifdef/'ifndef - `else ifdef - `endif, the define statement, fork and join, $value$plusargs. , the `include statement, filelists, importing packages

UNIT	TITLE	PERIODS
3	**Universal Verification Methodology**	**18**

Introduction to UVM, Interfaces – definitions, implementation, connections, concurrence, reuse, hierarchy. Tasks – task/endtask, arguments, lifetime, calls, execution and synchronization. run_test() keyword, Checkers – checker/end checker, assertions, monitoring and reporting, coverage, functional coverage

UNIT	TITLE	PERIODS
4	**Functions And Classes**	**15**

Introduction to functions – function/end function, arguments, concept of a lifetime, scope, concept of side effects, void functions. Introductions to Classes – class/end class, objects, constructors, methods, access modifiers, inheritance and polymorphism	
TOTAL PERIODS	**54**
COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Write testbenches to verify complex functional blocks
CO2:	Write checkers, interfaces, tests, tasks
CO3:	Debug advanced models
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Samir Palnitkar, " Verilog HDL : A Guide to Digital Design and Synthesis", Pearson Education, 2003.
2.	Sahu P. P., "VLSI Design", Tata McGraw Hill
3.	Brian Holdsworth, Clive Woods , "Digital Logic Design", Elsevier Science, 2002.
4.	M. Morris Mano, "Digital Logic and Computer Design", Pearson India, 2017.
5.	Debashis De, "Digital Design Using Verilog: A Simplified Approach, PHI learning pvt ltd, 2013
6.	A.P. Godse and D.A. Godse, "Sequential Logic: Analysis and Synthesis", Technical Publications, 2008

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	VHDL PROGRAMMING	**3**	**0**	**0**	**3**

PREREQUISITES:

Digital Logic Design
Digital Logic Design Lab

COURSE OBJECTIVES:

1.	Introduce students to VHDL programming
2.	Appreciate the commonality between Hardware Description Languages

UNIT	TITLE	PERIODS
1	**Introduction to VHDL**	**12**

Introduction to FPGAs & ASICs, use of VHDL in FPGA design flow, Rules and Syntax, statements, identifiers, keywords, language structure, assignments, operators, Types, interface ports. Review of finite state machines

UNIT	TITLE	PERIODS
2	**Introduction to Modelsim & Code Evaluation**	**12**

Introduction, simulation, Design hierarchy, Debugging, Testbench generation, Timing, Libraries and integration.

UNIT	TITLE	PERIODS
3	**Logic Design**	**15**

Combinational Circuits, Latches and Flip Flops, Counters & Registers, Buses and Tri State buffers, , components, generate and Loops , Combinational and Synchronous testbenches, Memories & Finite State Machines

UNIT	TITLE	PERIODS
4	**Advanced Modeling**	**15**

Modeling a commercially available Binary counter, ROM/RAM/SRAM Modeling, ALU and FIFO modeling

TOTAL PERIODS	**54**

COURSE OUTCOMES	
Upon completion of this course, students will:	
CO1:	Create Models/descriptions for Digital functions in VHDL
CO2:	Create testbenches using ModelSim and VHDL
CO3:	Debug model and tool error messages
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION	
1.	Gaganpreet Kaur, “VHDL: Basics to Programming”, Pearson,
2.	Stephen Brown & Zvonko Vranesic: Fundamentals of Digital Logic Design with VHDL (Special Indian Edition), Jan 2006
3.	Agarwal, Kumar, “VHDL:Analysis and Modeling of Digital Systems”, BS Publications, 2005
4.	Bagad, Puntambekar, “VHDL for Engineers”, Technical Publications, 2008
5.	Bhasker, “VHDL Primer”, PHI, 2002

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	ELECTRIC VEHICLES	**3**	**0**	**0**	**3**

PREREQUISITES:

NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:

1.	To learn the fundamentals of Hybrid Electric Vehicle
2.	To learn the various Electric Drives
3.	To learn Energy Storage and Its working principles
4.	To learn Energy Management System
5.	To know the fundamentals of electrical vehicles

UNIT	TITLE	PERIODS
1	**Introduction to Hybrid Electric Vehicle**	**11**

Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving

UNIT	TITLE	PERIODS
2	**Electric Drives**	**11**

Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric
Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor

UNIT	TITLE	PERIODS
3	**Energy Storage**	**10**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles:- Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system, Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle

UNIT	TITLE	PERIODS
4	**Energy Management System**	**11**

Energy Management Strategies, Automotive networking and communication, EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges		
UNIT	**TITLE**	**PERIODS**
5	**Mobility and Connectors**	**11**
Connected Mobility and Autonomous Mobility- case study Emobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. Connectors- Types of EV charging connector, North American EV Plug Standards, DC Fast Charge EV Plug Standards in North America, CCS (Combined Charging System), CHAdeMO, Tesla, European EV Plug Standards,		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	the fundamentals of Hybrid Electric Vehicle	
CO2:	the various Electric Drives and it working	
CO3:	How to do Energy Storage and Its working principles	
CO4:	The Energy Management System	
CO5:	the fundamentals of electrical vehicles	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003	
2.	Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010	
3.	Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012	
4.	Tariq Muneer and Irene Illescas-García, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017	
5.	Agarwal, "Electric Vehicles Technology", Wiley India Pvt. Ltd., 2011	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	TRANSMISSION LINES	**3**	**0**	**0**	**3**

PREREQUISITES:

Applied mathematics for electronics - I
Applied mathematics for electronics – II
Basic Analog Circuits – operation and layout

COURSE OBJECTIVES:

1.	Introduction to distributed circuits
2.	Introduction to Transmission Lines
3.	Provide sufficient background for further exploration

UNIT	TITLE	PERIODS
1	**Interconnect Delay and Characteristic Impedance**	**9**

Review of lumped circuits - the idea of zero interconnect delay, transmission lines - non zero interconnect delay, velocity of propagation, speed of light/EM Waves in different media , The idea of both current and voltage propagating along an interconnect, infinitely long interconnects, matched termination

UNIT	TITLE	PERIODS
2	**Transmission Line Termination**	**15**

Mismatched terminations and their effect of the signal – reflections, reflection coefficient, analysis of open and short terminations and their effect on signal current and voltage, resistive terminations, forward and returning waves, Standing waves

UNIT	TITLE	PERIODS
3	**Distributed Circuits – Simulation & Modeling**	**15**

Introduction to distributed circuits, approximating a distributed circuit with lumped elements, lossless transmission line distributed model, modeling a transmission line with lumped elements, simulating with varying degrees of resolution and precision, simulation time Vs accuracy, modeling convergence

UNIT	TITLE	PERIODS
4	**S11 & S12, LOSS**	**15**

Power transfer, gain to dB conversion, S11, transmission line loss, S12, Qualitative analysis of lossy transmission line with termination		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Understand transmission lines	
CO2:	Analyze transmission line behavior with different terminations	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Dananjayan, “Transmission Lines and Waveguides”, Lakshmi publications, 2014	
2.	Shevgaonkar R. K., “Electromagnetic Waves”, 2017	
3.	Sinha, Gupta, “Transmission Lines and networks”, Satya Prakashan, 2018	
4.	Saraf, Sharma, “Transmission Lines and Waveguides”, S. Chand, 2007	
5.	Kraus, “Electromagnetics”, Tata McGraw-Hill, 2003	

Course Code	Course Title	Periods per week			Credits
		L	T	P	
	PROJECT MANAGEMENT	**3**	**0**	**0**	**3**

PREREQUISITES:

Programming, English

COURSE OBJECTIVES:

1.	Introducing the primary important concepts of project management related to managing software development projects
2.	They will also get familiar with the different activities involved in Software Project Management
3.	Further, they will also come to know how to successfully plan and implement a software project management activity, and to complete a specific project in time with the available budget
4.	To study about project management, planning and software development process

UNIT	TITLE	PERIODS
1	**Software Process**	**10**

Process Maturity – Capability Maturity Model (CMM) – KPA Project Management, Variations in CMM - Productivity improvement process

UNIT	TITLE	PERIODS
2	**People Management**	**11**

Organization structure – Difficulties in people management - Effective team building – Role of Project manager - Team structures – Comparison of different team structures Software Metrics: Role of Metrics In Software Development - Project Metrics – Process Metrics – Data Gathering - Analysis Of Data For Measuring Correctness, Integrity, Reliability And Maintainability Of Software Products.

UNIT	TITLE	PERIODS
3	**Project Management and Planning**	**11**

Project initiation – standard process, Process Tailoring - Feasibility study - Planning – Estimation - Resource allocation - the Project Plan – Software Development Process – Defects

– Finding Defects – Code Review Checklist – Projecting Defects Inspection And Review: Need- Process of Inspection- SRS- Design Document Inspection		
UNIT	**TITLE**	**PERIODS**
4	**Project Scheduling and Tracking**	**11**
Scheduling - Critical path – Tracking - Timeline chart – Earned value chart. Software Configuration Management: Baselines - Software configuration items -The SCM process - Version control - Change control - Configuration audit - SCM standards		
UNIT	**TITLE**	**PERIODS**
5	**Working Capital Policy**	**11**
Importance of Working Capital Management – Risk- Risk analysis and management – Types of Risk involved - RMM plan- Return Tradeoff for Current Asset Investments – Financing Current Assets – The Costs and Risks of Alternative Debt Maturities. Quality Planning: Quality process - Quality control –Defect prevention process- Total Quality Management.		
	TOTAL PERIODS	**54**
COURSE OUTCOMES		
Upon completion of this course, students will:		
CO1:	Identify the different project contexts and suggest an appropriate management strategy	
CO2:	Practice the role of professional ethics in successful software development	
CO3:	Identify and describe the key phases of project management	
CO4:	Determine an appropriate project management approach through an evaluation of the business context and scope of the project	
CO5:	Describe project scheduling and project tracking	
REFERENCE MATERIAL: BOOKS, ONLINE REFERENCES & OTHER DOCUMENTATION		
1.	Pankaj Jalote, “Software Project Management in Practice”, Pearson Education publications,2002.	
2.	Krish Rangarajan and Anil Misra, “Working Capital Management”, Excel Book publications, 2005	
3.	Watts Humphrey, “Managing the Software Process”, Pearson publications, 2005.	
4.	Roger S Pressman, “Software Engineering – A Practitioner’s Approach”, McGraw Hill Publications, International Edition, Sixth Edition, 2007.	
5.	C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Publications,2008.	