

# **MOHAN BABU UNIVERSITY**

Sree Sainath Nagar, Tirupati – 517 102



**MBU**  
MOHAN BABU  
UNIVERSITY

DREAM. BELIEVE. ACHIEVE

## **SCHOOL OF ENGINEERING**

**M.Tech. VLSI and Embedded System Design**

**CURRICULUM AND SYLLABUS**

*(For 2022-23 Admitted Students)*

**FULLY FLEXIBLE CHOICE BASED CREDIT SYSTEM  
(FFCBCS)**



# **MOHAN BABU UNIVERSITY**

## **Vision**

To rise as one of the greatest hubs of innovation and entrepreneurship in the country, wherein students empower themselves with the best of knowledge, unleash their potential to the fullest, and soar high to attain a brighter future for themselves and the nation.

## **Mission**

- ❖ To provide relevant knowledge founded on the spirit of curiosity, compassion, courage and commitment.
- ❖ To uphold novel wings of leadership and excellence under expert mentors who guide students towards wisdom and knowledge.
- ❖ To create a dynamic learning environment that empowers learners with the right blend of passion and purpose to build a glorious tomorrow.

## **DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

### **VISION**

To be a center of excellence in the fields of Electronics, Communications and Instrumentation through teaching and research producing high quality engineering professionals and Entrepreneurs with values and ethics to meet local and global demands.

### **MISSION**

- ❖ Imparting knowledge through contemporary curriculum and striving for development of students with diverse background.
- ❖ Developing skills for enhancing employability of students through comprehensive training process.
- ❖ Inspiring students and faculty members for innovative research through constant interaction with research organizations and industry to meet societal needs.
- ❖ Inculcating ethics and values in students for effective engineering practice.

## **M.Tech. VLSI AND EMBEDDED SYSTEM DESIGN**

### **PROGRAM EDUCATIONAL OBJECTIVES**

After few years of graduation, the graduates of M. Tech. (VLSI & Embedded Systems Design) Program would have

- PEO1.** Pursued research studies in the core or allied areas.
- PEO2.** Successful entrepreneurial or technical career in the core or allied areas of VLSI and Embedded systems
- PEO3.** Continued to learn and to adapt evolving technologies in the core or allied areas of VLSI and Embedded systems.

### **PROGRAM OUTCOMES**

On successful completion of the Program, the graduates of M. Tech. (VLSI & Embedded Systems Design) will be able to:

- PO1.** Demonstrate mastery of knowledge in VLSI, Embedded Systems and other allied areas of the program.
- PO2.** Design and develop Integrated Circuits/systems for Digital and Mixed signal applications using advanced Microcontroller based systems and FPGA/ASICs.
- PO3.** Select and apply appropriate modern tools, techniques and resources to provide engineering solutions in VLSI and Embedded Systems.
- PO4.** Independently carry out research to deliver solutions for complex problems in the area of VLSI and Embedded Systems.
- PO5.** Communicate effectively in written and oral formats.
- PO6.** Ability to continuously engage in life-long learning to enhance knowledge and competence.

## M.Tech. VLSI and Embedded System Design

### Basket Wise - Credit Distribution

S. No.	Basket	Credits (Min.- Max.)
1	SCHOOL CORE	31-34
2	PROGRAM CORE	21-24
3	PROGRAM ELECTIVE	12-18
5	UNIVERSITY ELECTIVE	6
<b>TOTAL CREDITS</b>		<b>Min. 70</b>

## School Core (31-34 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EC201001	Computational Methods in Microelectronics	3	-	-	-	3	-
22EE201001	Research Methodology	3	-	-	-	3	-
22EE201002	Innovations and Intellectual Property Rights	2	-	-	-	2	-
22EC211001	Internship	-	-	-	-	2	-
22EC209001	Project Work Phase-I	-	-	-	-	10	-
22EC210001	Project Work Phase-II	-	-	-	-	14	-
<b>Mandatory Courses (Min. 4 Credits) Earned Credits will not be considered for CGPA</b>							
22AI207601	Statistics with R	2	-	-	-	2	-
22LG207601	Technical Report Writing	2	-	-	-	2	-
22MG207601	Project Management	2	-	-	-	2	-
22MG207602	Essentials of Business Etiquettes	2	-	-	-	2	-

### Program Core (21-24 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22EC202002	Analog CMOS VLSI Design	3	-	3	-	4.5	-
22EC202003	Digital CMOS VLSI Design	3	-	3	-	4.5	-
22EC202004	VLSI Design Verification and Testing	3	-	3	-	4.5	-
22EC201005	Device Modeling	3	-	-	-	3	-
22EC201006	Advanced Computer Architecture	3	-	-	-	3	-
22EC202007	Embedded Systems Design	3	-	3	-	4.5	-

### Program Elective (12-18 Credits)

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
			L	T	P	S	C	
22EC201008	Digital VLSI	Network-on-Chip Design	3	-	-	-	3	Co Design, System-on-Chip Design
22EC201009		IC Fabrication	3	-	-	-	3	-
22EC202010		Nano Materials and Nanotechnology	3	-	3	-	4.5	IC Fabrication
22EC202011		Low Power CMOS VLSI Design	3	-	3	-	4.5	Digital CMOS VLSI Design
22EC201012	Mixed VLSI	CMOS RF Circuit Design	3	-	-	-	3	Analog CMOS VLSI Design
22EC201013		System-on-Chip Design	3	-	-	-	3	Digital CMOS VLSI Design

Course Code	Knowledge Area	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
			L	T	P	S	C	
22EC202014		Mixed Signal Design	3	-	3	-	4.5	-
22EC202015		FPGA Architectures	3	-	3	-	4.5	-
22EC201016		Physical Design Automation	3	-	-	-	3	Digital CMOS VLSI Design, FPGA Architectures
22EC202017		Memory Technologies	3	-	3	-	4.5	Digital CMOS VLSI Design, IC Fabrication, VLSI Design Verification and Testing
22EC203018		Reconfigurable Computing	3	-	-	4	4	FPGA Architectures
22EC203019		VLSI Digital Signal Processing	3	-	-	4	4	Computational Methods in Microelectronics
22EC201020		Embedded Systems	Electromagnetic Interference and Compatibility	3	-	-	-	3
22EC201021	Fault Tolerant and Dependable Systems		3	-	-	-	3	-
22EC201022	Communication Buses and Interfaces		3	-	-	-	3	Embedded Systems Design
22EC201023	Co Design		3	-	-	-	3	-
22EC202024	Real Time Systems		3	-	3	-	4.5	Embedded Systems Design
22EC203025	Advanced Embedded Systems		3	-	-	4	4	Embedded Systems Design

## University Elective (6 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits
		L	T	P	S	C
22AI201701	Business Analytics	3	-	-	-	3
22CM201701	Cost Management of Engineering Projects	3	-	-	-	3
22CE201701	Disaster Management	3	-	-	-	3
22SS201701	Value Education	3	-	-	-	3
22SS201702	Pedagogy Studies	3	-	-	-	3
22LG201701	Personality Development through Life Enlightenment Skills	3	-	-	-	3

**Note:**

1. If any student has chosen a course or equivalent course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s under University Elective.
2. The student can choose courses from other disciplines offered across the schools of MBU satisfying the pre-requisite other than the above list.



## SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
<b>22EE201001</b>	<b>RESEARCH METHODOLOGY</b>	3	-	-	-	3
<b>Pre-Requisite</b>	--					
<b>Anti-Requisite</b>	--					
<b>Co-Requisite</b>	--					

**COURSE DESCRIPTION:**

The course is developed for the students' to understand the underlying concepts of research methodology and a systematic approach for carrying out research in the domain of interest. The course is emphasised on developing skills to recognise and reflect the strength and limitation of different types of research; formulation of the research hypothesis and its systematic testing methods. The course also emphasises on interpreting the findings and research articulating skills along with the ethics of research.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

- CO1.** Demonstrate the underlying concepts of research methodology, types of research and the systematic research process.
- CO2.** Demonstrate the philosophy of research design, types of research design and develop skills for a good research design.
- CO3.** Demonstrate the philosophy of formulation of research problem, methods of data collection, review of literature and formulation of working hypothesis.
- CO4.** Analyse the data and parametric tests for testing the hypothesis.
- CO5.** Interpret the findings and research articulating skills along with the ethics of research.

**CO-PO Mapping Table:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	-	-	-	3	-	-
<b>CO2</b>	-	-	-	3	-	-
<b>CO3</b>	-	-	-	3	-	-
<b>CO4</b>	-	-	-	3	-	-
<b>CO5</b>	-	-	-	-	3	-
<b>Course Correlation Mapping</b>	-	-	-	<b>3</b>	<b>3</b>	-

**Correlation Levels:            3: High;            2: Medium;            1: Low**

## **COURSE CONTENT**

### **Module 1: Introduction to Research Methodology (08 Periods)**

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research.

### **Module 2: Research Design (08 Periods)**

Research design—Basic Principles, Need of research design, Features of good design, Important concepts relating to research design, Different research designs, Basic principles of experimental designs, Developing a research plan.

### **Module 3: Research Formulation (08 Periods)**

Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem - Data collection - Primary and secondary sources; Critical literature review - Identifying gap areas from literature review; Hypothesis— Types of hypothesis, Development of working hypothesis.

### **Module 4: Analysis of Data and Hypothesis Testing (14 Periods)**

**Quantitative Tools:** Testing and Significance of Measures of Central Tendency, Dispersion; correlation, Principles of least squares—Regression; Errors-Mean Square error, Mean absolute error, Mean absolute percentage errors.

**Testing of Hypothesis:** Hypothesis Testing Procedure, Types of errors, Parametric testing (t, z and F), Chi-Square Test as a Test of Goodness of Fit; Normal Distribution- Properties of Normal Distribution; Analysis of Variance.

### **Module 5: Interpretation and Report Writing (07 Periods)**

**Interpretation:** Meaning of interpretation; Techniques of interpretation; Precautions in Interpretation.

**Report Writing** –Significance, Different Steps, Layout, Types of reports, Mechanics of Writing a Research Report, Precautions in Writing Reports; Research ethics—Plagiarism, Citation and acknowledgement.

**Total Periods: 45**

## **EXPERIENTIAL LEARNING**

1. Should conduct a survey based on a hypothesis, analyze the data collected and draw the inferences from the data.
2. Should review the literature on the given topic and should identify the scope/gaps in the literature and develop a research hypothesis.
3. Should study a case, formulate the hypothesis and identify an appropriate testing technique for the hypothesis.
4. Study an article and submit a report on the inferences and should interpret the findings of the article.

### **TEXT BOOKS:**

1. C.R. Kothari, Research Methodology: Methods and Techniques, New Age International Publishers, 2<sup>nd</sup> revised edition, New Delhi, 2004.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, An introduction to Research Methodology, RBSA Publishers, 2002.

**REFERENCE BOOKS:**

1. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.
2. Singh, Yogesh Kumar. *Fundamental of research methodology and statistics*. New Age International, 2006.

**VIDEO LECTURES:**

1. <https://nptel.ac.in/courses/121106007>
2. [https://onlinecourses.nptel.ac.in/noc22\\_ge08/preview](https://onlinecourses.nptel.ac.in/noc22_ge08/preview)
3. <https://www.youtube.com/watch?v=VK-rnA3-41c>

**Web Resources:**

1. <https://www.scribbr.com/category/methodology/>
2. <https://leverageedu.com/blog/research-design/>
3. <https://prothesiswriter.com/blog/how-to-formulate-research-problem>
4. <https://www.formpl.us/blog/hypothesis-testing>
5. <https://www.datapine.com/blog/data-interpretation-methods-benefits-problems/>
6. <https://leverageedu.com/blog/report-writing/>

## SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE201002	<b>INNOVATION AND INTELLECTUAL PROPERTY RIGHTS</b>	2	-	-	-	2
<b>Pre-Requisite</b>	--					
<b>Anti-Requisite</b>	--					
<b>Co-Requisite</b>	--					

### COURSE DESCRIPTION:

The course is designed to provide comprehensive knowledge to the students regarding the general principles of innovation and intellectual property rights, significance of innovation and steps for innovation, Concept and Theories, Criticisms of Intellectual Property Rights, International Regime Relating to IPR. The course provides an awareness on how to protect ones unique creation, claim ownership, knowledge of what falls under the purview of someone's rights and what doesn't, and safeguard their creations and gain a competitive edge over the peers.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Understand the significance of innovation and steps for innovative thinking, and the concepts of intellectual property right and avenues for filling intellectual property rights.
- CO2.** Understand the legislative practices and protocols for acquisition of trademark and the judicial consequences for violating laws of trademark protection.
- CO3.** Understand the legislative practices and protocols for acquisition of copyrights and the judicial consequences for violating laws of copyrights protection.
- CO4.** Understand the fundamentals of patent laws, legislative practices and protocols for acquisition of trade secrets and the judicial consequences for violating laws of trade secrets protection.
- CO5.** Understand the latest developments and amendments in protection and filling of intellectual rights at international level.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	-	-	-	-	-	3
<b>CO2</b>	-	-	-	-	-	3
<b>CO3</b>	-	-	-	-	-	3
<b>CO4</b>	-	-	-	-	-	3
<b>CO5</b>	-	-	-	-	-	3
<b>Course Correlation Mapping</b>	-	-	-	-	-	<b>3</b>

**Correlation Levels: 3: High; 2: Medium; 1: Low**

## COURSE CONTENT

### **Module 1: Introduction to Innovation and IPR (06 Periods)**

**Innovation:** Difference between Creativity and Innovation – Examples of innovation; Being innovative; Identify Blocks for creativity and innovation – overcoming obstacles; Steps for Innovation

**Intellectual property rights:** Need for intellectual property rights (IPR); types of intellectual property- Design, Geographical Indication; International organizations, agencies and treaties.

### **Module 2: Trademarks (06 Periods)**

Introduction to trademark, Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

### **Module 3: Law of Copyrights (06 Periods)**

Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

**Law of patents:** Foundation of patent law, patent searching process, ownership rights and transfer.

### **Module 4: Trade Secrets (06 Periods)**

Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

**Unfair competition:** Misappropriation right of publicity, false advertising.

### **Module 5: New Development of Intellectual Property (06 Periods)**

New developments in: trade mark law, copy right law, patent law, intellectual property audits. International overview on intellectual property; international - trade mark law, copy right law, international patent law, international development in trade secrets law.

**Total Periods: 30**

## EXPERIENTIAL LEARNING

1. Should conduct a survey based on the real scenario, where IPR is misused or unethically used and present an article.
2. Prepare an article on the registration processes of IPR practically (copy right/trade mark/ patents).
3. Should study a case of conflict on trademarks/patents and should produce an article mentioning the circumstances and remedial measures.
4. Prepare an article on the latest development in the international intellectual property rights.
5. Refining the project, based on the review report and uploading the text

## RESOURCES

### TEXT BOOKS:

1. Deborah, E. Bouchoux, *Intellectual property: The law of Trademarks, Copyright, Patents, and Trade Secrets*, Cengage learning, 4<sup>th</sup> Edition, 2013.
2. Prabuddha Ganguli, *Intellectual property right - Unleashing the knowledge economy*, McGraw Hill Education, 1<sup>st</sup> Edition, 2017.
3. Tom Kelley & Jonathan Littman, *The Art of Innovation*, Profile Books Ltd, UK, 2008

### REFERENCE BOOKS:

1. Neeraj P., & Khusdeep D, *Intellectual Property Rights*, PHI learning Private Limited, 1<sup>st</sup> Edition, 2019.
2. Nithyananda, K V. *Intellectual Property Rights: Protection and Management*, Cengage Learning India Private Limited, 2019
3. Edward debone, *How to have Creative Ideas*, Vermilon publication, UK, 2007.

### VIDEO LECTURES:

1. <https://nptel.ac.in/courses/110105139>
2. <https://www.youtube.com/watch?v=bEusrD8g-dM>
3. <https://www.youtube.com/watch?v=LS7TTb23nzU>

### Web Resources:

1. <http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf>
2. [https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo\\_pub\\_489.pdf](https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf)
3. <http://cipam.gov.in/>
4. <https://www.wipo.int/about-ip/en/>
5. <http://www.ipindia.nic.in/>

## SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22AI207601	STATISTICS WITH R	2	-	-	-	2

**Pre-Requisite** -

**Anti-Requisite** -

**Co-Requisite** -

**COURSE DESCRIPTION:** This course introduces the basic concepts of statistics using R language. The course also deals with various types of sampling methods and its impact in the scope of inference through the computation of confidence intervals. The topics covered in the course also includes descriptive statistics, marginal and conditional distribution, statistical transformations, chi-squared test and ANOVA.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Import, manage, manipulate, structure data files and visualize data using R programming.
- CO2.** Identify trends and patterns in data using Marginal, Conditional distributions and Statistical transformations.
- CO3.** Analyse data using sampling and probability distribution methods and compute confidence intervals for statistical inference.
- CO4.** Apply chi-squared goodness-of-fit test, Pearson's  $\chi^2$ -statistic and ANOVA to investigate the distribution of data.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	2	-	-	-	-
<b>CO2</b>	3	2	-	-	-	-
<b>CO3</b>	2	2	-	-	-	-
<b>CO4</b>	3	2	-	-	-	-
<b>Course Correlation Mapping</b>	3	2	-	-	-	-

**Correlation Levels: 3: High; 2: Medium; 1: Low**

## COURSE CONTENT

### Module 1: INTRODUCTION

(05 Periods)

Data, R's command line, Variables, Functions, The workspace, External packages, Data sets, Data vectors, Functions, Numeric summaries, Categorical data.

### Module 2: BIVARIATE AND MULTIVARIATE DATA

(07 Periods)

Lists, Data frames, Paired data, Correlation, Trends, Transformations, Bivariate categorical data, Measures of association, Two-way tables, Marginal distributions, Conditional distributions, Graphical summaries, Multivariate data - Data frames, Applying a function over a collection, Using external data, Lattice graphics, Grouping, Statistical transformations.

### Module 3 POPULATIONS

(06 Periods)

Populations, Discrete random variables, Random values generation, Sampling, Families of distributions, Central limit theorem, Statistical Inference - Significance tests, Estimation, Confidence intervals, Bayesian analysis.

### Module 4 CONFIDENCE INTERVALS

(06 Periods)

Confidence intervals for a population proportion,  $\mu$  - population mean, other confidence intervals, Confidence intervals for differences, Confidence intervals for the median, Significance test - Significance test for a population proportion, Significance test for the mean (t-tests), Significance tests and confidence intervals, Significance tests for the median.

### Module 5 GOODNESS OF FIT

(06 Periods)

The chi-squared goodness-of-fit test, The multinomial distribution, Pearson's  $\chi^2$ -statistic, chi-squared test of independence and homogeneity, Goodness-of-fit tests for continuous distributions, ANOVA - One-way ANOVA, Using *lm* for ANOVA.

**Total Periods: 30**

## EXPERIENTIAL LEARNING

1. The data set baby boom (Using R) contains data on the births of 44 children in a one-day period at a Brisbane, Australia, hospital. Compute the skew of the wt variable, which records birth weight. Is this variable reasonably symmetric or skewed? The variable running.time records the time after midnight of each birth. The command diff(running.time) records the differences or inter-arrival times. Is this variable skewed?
2. An elevator can safely hold 3, 500 pounds. A sign in the elevator limits the passenger count to 15. If the adult population has a mean weight of 180 pounds with a 25-pound standard deviation, how unusual would it be, if the central limit theorem applied, that an elevator holding 15 people would be carrying more than 3, 500 pounds?
3. The data set MLB Attend (Using R) contains attendance data for Major League Baseball between the years 1969 and 2000. Use *lm* to perform a t-test on attendance for the two levels of league. Is the difference in mean attendance significant? Compare your results to those provided by t-test.



## RESOURCES

### TEXT BOOKS:

1. John Verzani, *Using R for Introductory Statistics*, CRC Press, 2<sup>nd</sup> Edition, 2014.
2. Sudha G Purohit, Sharad D Gore, Shailaja R Deshmukh, *Statistics Using R*, Narosa Publishing house, 2<sup>nd</sup> Edition, 2021.

### REFERENCE BOOKS:

1. Francisco Juretig, *R Statistics Cookbook*, Packt Publishing, 1<sup>st</sup> Edition, 2019.
2. Prabhanjan N. Tattar, Suresh Ramaiah, B. G. Manjunath, *A Course in Statistics with R*, Wiley, 2018.

### VIDEO LECTURES:

1. [https://onlinecourses.nptel.ac.in/noc21\\_ma76/preview](https://onlinecourses.nptel.ac.in/noc21_ma76/preview)
2. [https://onlinecourses.nptel.ac.in/noc19\\_ma33/preview](https://onlinecourses.nptel.ac.in/noc19_ma33/preview)
3. <https://youtu.be/WbKiJe5OkUU?list=PLFW6IRTa1g83jjpIOte7RuEYCwOJa-6Gz>
4. <https://youtu.be/svDAkvh6utM?list=PLFW6IRTa1g83jjpIOte7RuEYCwOJa-6Gz>
5. <https://nptel.ac.in/courses/111104120>

### WEB RESOURCES:

1. <https://www.geeksforgeeks.org/r-statistics/>
2. <https://www.geeksforgeeks.org/r-programming-exercises-practice-questions-and-solutions/>
3. [https://www.w3schools.com/r/r\\_stat\\_intro.asp](https://www.w3schools.com/r/r_stat_intro.asp)
4. [https://www.w3schools.com/r/r\\_stat\\_intro.asp](https://www.w3schools.com/r/r_stat_intro.asp)
5. <https://statsandr.com/blog/descriptive-statistics-in-r/>

## SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
<b>22LG207601</b>	<b>TECHNICAL REPORT WRITING</b>	2	-	-	-	2
<b>Pre-Requisite</b>	-					
<b>Anti-Requisite</b>	-					
<b>Co-Requisite</b>	-					

**COURSE DESCRIPTION:** This course deals with preparing effective technical documents for both written and digital media, with particular emphasis on technical memos, problem-solving and decision-making reports, and organizational, product-support, and technical-information webs.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Demonstrate knowledge of Technical Report Writing and structures with a scientific attitude.
- CO2.** Analyze the process of writing in preparing effective reports.
- CO3.** Demonstrate styles of writing for Publication in a Scientific Journal.
- CO4.** Apply the process of referencing and editing techniques for effective communication in written documents.
- CO5.** Analyze the strategies in the technical report presentation.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	-	-	-	-	3	-
<b>CO2</b>	-	-	-	-	3	-
<b>CO3</b>	-	-	-	-	3	-
<b>CO4</b>	-	-	-	-	3	-
<b>CO5</b>	-	-	-	-	3	-
<b>Course Correlation Mapping</b>	-	-	-	-	<b>3</b>	-

**Correlation Levels:            3: High;            2: Medium;            1: Low**

## **COURSE CONTENT**

### **Module 1: INTRODUCTION TO TECHNICAL REPORT WRITING (06 Periods)**

Concepts of Technical Report, Types of Reports, Planning Technical Report Writing, Components of a Technical Report, Report Writing in Science and Technology, Selecting and Preparing a Title, Language Use in Report Writing.

### **Module 2: PROCESS OF WRITING (06 Periods)**

Writing the 'Introduction', Writing the 'Materials and Methods', Writing the Findings/Results, Writing the 'Discussion', Preparing and using "Tables".

### **Module 3: STYLE OF WRITING (06 Periods)**

Preparing and using Effective 'Graphs', Citing and Arranging References-I, Citing and Arranging References -II, Writing for Publication in a Scientific Journal.

### **Module 4: REFERENCING (06 Periods)**

Literature citations, Introductory remarks on literature citations, Reasons for literature citations, Bibliographical data according to ISO standards, Citations in the text, Copyright, and copyright laws, the text of the Technical Report, Using a word processing and desktop publishing (DTP) systems, Document or page layout, hints on editing Typographic details, Cross-references.

### **Module 5: PRESENTATION (06 Periods)**

Presentation with appropriate pointing, Dealing with intermediate questions, Review and analysis of the presentation, Rhetoric tips from A to Z.

**Total Periods: 30**

## **EXPERIENTIAL LEARNING**

1. Prepare a report on technologies of modern times that enriched the originality of research works and their impacts on society concerning plagiarism.
2. Make PowerPoint presentations on the various style of writing academic reports.
3. Error-free Reports are so important for successful communication and sharing of information. Prepare a detailed chart on proofreading techniques to make a report effective and error-free.
4. Design a logo for a company and write down the copy-right laws for that.
5. Read research articles from any international journal of science and technology and differentiate research writing from other academic and non-academic writings.
6. Write an organizational memo Include a heading, introduction, and summary at the beginning of your memo, and present the details of your discussion in a logical order. Use headings and topic or main-idea sentences to clarify the organization.
7. Prepare an appraisal report on the staff performance of your company.
8. Prepare a PowerPoint presentation on the annual performance report of a company.
9. Critically review and write a report on any one of the recently released products.
10. Read the newspaper and write a detailed report about the content coverage and analyse the factors for the popularity of the newspaper.

## **RESOURCES**

### **TEXTBOOK**

1. RC Sharma and Krishna Mohan, "*Business Correspondence and Report Writing*", McGraw-Hill Publishing, 3<sup>rd</sup> Edition, 2005 (reprint).
2. Patrick Forsyth, "*How to Write Reports and Proposals*", The Sunday Times, Kogan Page, New Delhi, Revised 2<sup>nd</sup> Edition, 2010.

### **REFERENCE BOOKS:**

3. John Seely, "*The Oxford Writing & Speaking*", Oxford University Press, Indian Edition
4. Anne Eisenberg, "*A Beginner's Guide to Technical Communication*", McGraw-Hill Education (India) Private Limited, New Delhi, 2013.

### **VIDEO LECTURES:**

1. <https://vimeo.com/143714818>
2. [https://digitalmedia.sheffield.ac.uk/media/002.+The+Anatomy+of+a+Technical+Report/1\\_u8wntcge](https://digitalmedia.sheffield.ac.uk/media/002.+The+Anatomy+of+a+Technical+Report/1_u8wntcge)

### **Web Resources:**

1. <http://www.resumania.com/arcindex.html>
2. <http://www.aresearchguide.com/writing-a-technical-report.htm>
3. <http://www.sussex.ac.uk/ei/internal/forstudents/engineeringdesign/studyguides/technical-report-writing>

## PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EC202002	<b>ANALOG CMOS VLSI DESIGN</b>	3	-	3	-	4.5
<b>Pre-Requisite</b>	-					
<b>Anti-Requisite</b>	-					
<b>Co-Requisite</b>	-					

**COURSE DESCRIPTION:** This course provides a detailed discussion and hands-on experience on MOS device physics, characteristics of amplifiers, feedback circuits and operational amplifiers, Stability and frequency compensation of operational amplifiers, Nonlinear Analog circuits & other applications.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Analyze single stage amplifiers, current mirrors, and differential amplifiers for opamp based data converter applications.
- CO2.** Analyze the frequency response of various amplifiers along with equivalent noise models, feedback amplifiers and operational amplifiers for improving performance of filters and instrumentation amplifiers.
- CO3.** Apply appropriate stability and frequency compensation techniques and Bandgap references for stable and high speed designs.
- CO4.** Apply techniques to develop switched capacitor circuits, oscillators and PLL.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	2	2	-	-	-
<b>CO2</b>	3	2	2	-	-	-
<b>CO3</b>	3	2	3	-	-	-
<b>CO4</b>	3	2	3	-	-	-
<b>Course Correlation Mapping</b>	<b>3</b>	<b>2</b>	<b>3</b>	-	-	-

**Correlation Levels:            3: High;            2: Medium;            1: Low**

## COURSE CONTENT

### **Module 1: BASIC MOS DEVICE PHYSICS AND SINGLE STAGE (11 Periods) AMPLIFIERS**

**Basic MOS Device Physics:** General Considerations, MOS I/V Characteristics, Second-Order Effects.

**Single Stage Amplifiers:** Basic Concepts, Common-Source Stage, Source follower, Common Gate Stage, Cascode Stage, Differential Amplifiers-Single Ended and Differential Operation, Basic Differential Pair. Passive and Active Current Mirrors.

### **Module 2: FREQUENCY RESPONSE AND NOISE CHARACTERISTICS (08 Periods) OF AMPLIFIERS**

**Frequency Response**-General Considerations, Common-Source Stage, Source follower, Common Gate Stage, Cascode Stage, Differential pair.

**Noise**-Statistical Characteristics of Noise, Noise in Single Stage Amplifiers, Noise in Differential Pairs.

### **Module 3: FEEDBACK CIRCUITS AND OPERATIONAL AMPLIFIERS (10 Periods)**

**Feedback Circuits** - General considerations, Feedback Topologies, Effect of Loading, Effect of Feedback on Noise.

**Operational Amplifiers** - General considerations, One-stage Op Amps, Two - stage Op Amps, Gain Boosting, Input range limitations, slew rate, power supply rejection, Noise in Op Amps.

### **Module 4: STABILITY & FREQUENCY COMPENSATION AND (08 Periods) BANDGAP REFERENCES**

**Stability & Frequency Compensation:** General considerations, Multipole Systems, Phase Margin, Frequency Compensation, Compensation of Two-Stage Op Amps.

**Bandgap References:** Supply-Independent Biasing, Temperature-independent References, PTAT Current Generation, Constant - Gm Biasing, Speed and Noise Issues.

### **Module 5: NONLINEAR ANALOG CIRCUITS & APPLICATIONS (08 Periods)**

Sampling Switches, Switched-Capacitor Amplifiers, Switched capacitor integrator, Ring oscillators, Simple PLL.

**Total Periods: 45**

## EXPERIENTIAL LEARNING

### LIST OF EXERCISES:

1. Model the single stage amplifiers (Common Source Amplifier, Common Drain Amplifier, Common Gate Amplifier) using SPICE Language, develop their schematic and layout to evaluate the Parameters like Gain, Output Resistance, Power Dissipation, etc.
2. Model the Differential Amplifiers using SPICE Language, develop their schematic and layout to evaluate the Parameters like Gain, Output Resistance, Power Dissipation, etc.
3. Model the Cascode Amplifiers using SPICE Language, develop their schematic and layout to evaluate the Parameters like Gain, Output Resistance, Power Dissipation, etc.

4. Model the Operational amplifiers using SPICE Language, develop their schematic and layout to evaluate the Parameters like gain, Output Resistance, Power Dissipation, etc.
5. Model the Feedback Amplifiers using SPICE Language, develop their schematic and layout to evaluate the Parameters like gain, Output Resistance, Power Dissipation, etc.
6. Model and apply the gain boosting techniques to CMOS amplifiers using SPICE Language, develop their schematic and layout to evaluate the Parameters like Gain, Power Dissipation, etc.
7. Model and apply the frequency compensation techniques to CMOS amplifiers using SPICE Language, develop their schematic and layout to obtain their frequency response.
8. Model Bandgap Reference Circuits by using SPICE Language, develop their schematic and layout to obtain their Characteristics.
9. Model Sampling Switches using SPICE Language, develop their schematic and layout to obtain their characteristics.
10. Model Switched Capacitor Amplifier and Integrator using SPICE Language, develop their schematic and layout to obtain their characteristics.
11. Model Ring Oscillator using SPICE Language, develop their schematic and layout to obtain their characteristics.
12. Model Phase Locked Loop using SPICE Language, develop their schematic and layout to obtain their characteristics.

## **RESOURCES**

### **TEXT BOOKS:**

1. Behzad Razavi, *Design of Analog CMOS Integrated Circuit*, Tata-McGrawHill, 2<sup>nd</sup> Edition, 2017.

### **REFERENCE BOOKS:**

1. D.A. John & Ken Martin, *Analog Integrated Circuit Design*, John Wiley, 2<sup>nd</sup> Edition, 2013.
2. Philip Allen & Douglas Holberg, *CMOS Analog Circuit Design*, Oxford University Press, 3<sup>rd</sup> Edition, 2013.

### **SOFTWARE/TOOLS:**

1. Software: Cadence/ synopsys/ mentor graphics/ DSCH and Microwind Tools/ Symica TCAD Tools

### **VIDEO LECTURES:**

1. <https://nptel.ac.in/courses/117101105>
2. [https://onlinecourses.nptel.ac.in/noc21\\_ee51/preview](https://onlinecourses.nptel.ac.in/noc21_ee51/preview)
3. [https://www.udemy.com/course/analog\\_ic\\_design\\_overview/](https://www.udemy.com/course/analog_ic_design_overview/)

## PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EC202003	DIGITAL CMOS VLSI DESIGN	3	-	3	-	4.5
<b>Pre-Requisite</b>	-					
<b>Anti-Requisite</b>	-					
<b>Co-Requisite</b>	-					

**COURSE DESCRIPTION:** This course provides a detailed discussion and hands-on experience on Characteristics of CMOS digital circuits; Transistor sizing; memory design; Design strategies; Design of subsystems.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Analyze the characteristics of CMOS Inverter and Design combinational and sequential logic circuits using various design styles.
- CO2.** Analyze timing issues to improve the performance of sequential logic circuits.
- CO3.** Design memories and sub systems using CMOS logic for high speed networks.
- CO4.** Understand design methodologies and tools at various levels of abstraction.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	3	-	-	-	-
<b>CO2</b>	3	3	-	-	-	-
<b>CO3</b>	3	-	-	-	-	-
<b>CO4</b>	3	3	-	-	-	-
<b>Course Correlation Mapping</b>	<b>3</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

**Correlation Levels:            3: High;            2: Medium;            1: Low**



## **COURSE CONTENT**

### **Module 1: CMOS INVERTER CHARACTERISTICS AND DESIGN (09 Periods) STYLES**

**MOS Inverters:** Introduction, Definitions and Properties, Static CMOS Inverter, Static and Dynamic Power Dissipation, CMOS inverter delay time definitions and calculations.

**Designing Combinational Logic Gates in CMOS:** Introduction, Static CMOS Design, Dynamic CMOS Design, Domino and NORA logic, Power Consumption in CMOS Gates.

### **Module 2: DESIGNING SEQUENTIAL LOGIC GATES IN CMOS (10 Periods)**

Introduction, Static Sequential Circuits, Dynamic Sequential Circuits, Non-Bistable Sequential Circuit, Logic Style for Pipelined Structures.

**Timing Issues in Digital Circuits:** Introduction, Clock Skew and Sequential Circuit Performance, Clock Generation and Synchronization

### **Module 3 HIGH SPEED NETWORK AND MEMORY DESIGN (9 Periods)**

Methods of Logical Effort for transistor sizing - Power consumption in CMOS Gates, Low power CMOS design. CMOS Memory design – SRAM, DRAM.

### **Module 4 SUBSYSTEM DESIGN PROCESS (9 Periods)**

General arrangement of 4-bit Arithmetic Processor, Design of 4-bit shifter, Design of ALU sub-system, Implementing ALU functions with an adder, Multipliers, modified Booth's algorithm

### **Module 5 DESIGN METHODOLOGY AND TOOLS (08 Periods)**

Introduction, Structured Design Strategies, Design Methods, Design Flows, Design Economics, Data Sheets and Documentation.

**Total Periods: 45**

## **EXPERIENTIAL LEARNING**

### **List of Exercises:**

Design, Synthesize and Implement the following logic circuits using LTSpice:

1. CMOS inverter.
2. Transmission Gate.
3. Pseudo static Circuit.
4. True Single phase clocked Edge Triggered Circuit.
5. Bistable Sequential Circuit
6. Astable Sequential Circuit
7. Dynamic CMOS
8. SRAM& DRAM
9. 4-bit shifter
10. ALU sub-system
11. Sequential Circuit with and without Pipelining
12. 4-bit Arithmetic Processor

## RESOURCES

### TEXT BOOKS:

1. Jan M Rabaey, *Digital Integrated Circuits*, Pearson Education, 2nd Edition, 2003
2. Sung-Mo Kang & Yusuf Leblebici, *CMOS Digital Integrated Circuits*, McGraw Hill, 3rd edition, 2003
3. Kamran Eshranghian, Douglas A.Pucknell and Sholeh Eshranghian, *Essential of VLSI Circuits and Systems*, PHI, 1st edition, 2005
4. Neil H. E. Weste, David Money Harris, *CMOS VLSI Design-A Circuit and Systems Perspective*", Pearson, 4th Edition,2011

### REFERENCE BOOKS:

1. Eugene D Fabricus, *Introduction to VLSI Design*, McGraw Hill International Edition, 1990
2. John P.Uyemura, *Introduction to VLSI Circuits and Systems*, John Wiley & sons, 1st Edition, 2002

### SOFTWARE /TOOLS:

Software: LTSPICE.

Hardware: Personal Computer with necessary peripherals, configuration and operating System.

### VIDEO LECTURES:

1. <https://www.digimat.in/nptel/courses/video/108107129/L01.html>

### Web Resources:

1. [https://kanchiuniv.ac.in/coursematerials/VLSI%20Design%20\\_%20GSK.pdf](https://kanchiuniv.ac.in/coursematerials/VLSI%20Design%20_%20GSK.pdf)
2. [https://www.tutorialspoint.com/vlsi\\_design/vlsi\\_design\\_sequential\\_mos\\_logic\\_circuits.htm](https://www.tutorialspoint.com/vlsi_design/vlsi_design_sequential_mos_logic_circuits.htm)
3. [https://www.researchgate.net/publication/353463964\\_Design\\_and\\_Optimization\\_of\\_4-BIT\\_Static\\_RAM\\_and\\_4-BIT\\_Dynamic\\_RAM\\_for\\_Compact\\_and\\_Portable\\_Devices](https://www.researchgate.net/publication/353463964_Design_and_Optimization_of_4-BIT_Static_RAM_and_4-BIT_Dynamic_RAM_for_Compact_and_Portable_Devices).
4. <https://slideplayer.com/slide/5005787/>.
5. [https://www.researchgate.net/publication/337144112\\_Enhanced\\_Modified\\_Booth\\_Recoding\\_Technique\\_for\\_Signal\\_Processing\\_Application](https://www.researchgate.net/publication/337144112_Enhanced_Modified_Booth_Recoding_Technique_for_Signal_Processing_Application).

## PROGRAM CORE

<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>S</b>	<b>C</b>
22EC202004	<b>VLSI DESIGN VERIFICATION AND TESTING</b>	3	-	3	-	4.5
<b>Pre-Requisite</b>	-					
<b>Anti-Requisite</b>	-					
<b>Co-Requisite</b>	-					

**COURSE DESCRIPTION:** This course provides knowledge in generation of test vectors for digital systems, to analyse and test various faults in digital system design and develop fault free applications, testing Combinational Circuits and Sequential Circuits, DFT Approaches and BIST Concepts.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Analyze Modelling of Digital Circuits at various levels of abstraction and various types of logic Simulations.
- CO2.** Understand the various fault models, reduction techniques to apply for fault sampling and simulation.
- CO3.** Apply the automatic test generation techniques for testing Single Stuck at Faults and bridging faults in digital circuits.
- CO4.** Analyze the various testing approaches and Built-In Self-Test architectures for testing digital circuits.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	-	3	-	-	-
<b>CO2</b>	3	3	-	-	-	-
<b>CO3</b>	3	-	-	-	-	-
<b>CO4</b>	3	-	-	-	-	-
<b>Course Correlation Mapping</b>	<b>3</b>	-	-	-	-	-

**Correlation Levels:            3: High;            2: Medium;            1: Low**

## **COURSE CONTENT**

### **Module 1: INTRODUCTION TO TESTING**

**(08 Periods)**

Modeling - Modeling Digital Circuits at Logic Level, Register Level and Structural Models. Level of Modeling, Logic Simulation- Types of Simulation, Delay Models, Element Evaluation, Hazard Detection, Gate Level Event Driven Simulation.

### **Module 2: FAULT MODELING AND SIMULATION**

**(9 Periods)**

Logic Fault Models, Fault Detection and Redundancy, Fault Equivalence and Fault Location, Fault Dominance, Fault Simulation Techniques, Fault Sampling.

### **Module 3 TESTING FOR STUCK FAULTS**

**(9 Periods)**

ATG for SSFs in Combinational Circuits and Sequential Circuits, Detection of Non feedback and Feedback Bridging Faults.

### **Module 4 DESIGN FOR TESTABILITY**

**(9 Periods)**

Controllability and Observability, Scan-Based Designs and Architecture, Board-Level and System-Level DFT Approaches, Compression Techniques, Syndrome Testing and Signature Analysis.

### **Module 5 BUILT-IN SELF TEST**

**(10 Periods)**

Introduction to BIST Concepts, Test - Pattern Generation, off-line BIST Architectures, Specific BIST Architectures – CSBL, BEST, RTS, LOCST, STUMPS, CBIST, CEBS, RTD, SST, CATS, CSTP, BILBO.

**Total Periods: 45**

## **EXPERIENTIAL LEARNING**

### **List of Exercises:**

Generate Lay out, Schematic Design of the following logic circuits using Microwind:

1. CMOS inverter
2. Transmission Gate
3. Basic/ Universal Gates
4. Flip flop -RS, D, JK, MS, T
5. Serial & Parallel adder
6. 4-bit counter [Synchronous and Asynchronous counter]
7. SRAM& DRAM
8. 4-bit shifter
9. ALU sub-system
10. Sequential Circuit with Pipelining
11. Dynamic CMOS
12. 4-bit Arithmetic Processor

## **RESOURCES**

### **TEXT BOOKS:**

1. Miron Abramovici, Melvin A. Breur, Arthur D.Friedman, *Digital Systems Testing and Testable Design*, Wiley, 1st Edition, 1994.

### **REFERENCE BOOKS:**

1. Alfred L. Crouch, *Design for Test for Digital ICs & Embedded Core Systems*, Prentice Hall PTR, 1<sup>st</sup> Reprint Edition, 1999.
2. Robert J. Feugate, Jr., Steven M.McIntyre, *Introduction to VLSI Testing*, Prentice Hall, 1<sup>st</sup> Illustrated Edition, 1998.

### **SOFTWARE /TOOLS:**

Software: Microwind.

Hardware: Personal Computer with necessary peripherals, configuration and operating System.

### **VIDEO LECTURES:**

1. <https://www.digimat.in/nptel/courses/video/117103125/L01.html>
2. <https://nptel.ac.in/courses/117103125>
3. <https://nptel.ac.in/courses/106103016/21>
4. <https://nptel.ac.in/courses/106105161/5>

### **Web Resources:**

1. <http://www2.eng.cam.ac.uk/~dmh/4b7/resource/section16.htm>

## PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
<b>22EC201005</b>	<b>DEVICE MODELING</b>	3	-	-	-	3

**Pre-Requisite** -

**Anti-Requisite** -

**Co-Requisite** -

**COURSE DESCRIPTION:** This course provides a detailed discussion on MOS Transistor; Small Dimension Effects; Ion Implanted Channels; MOS Transistor in Static and Dynamic operations and its Small signal Modeling.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Analyze the multi terminal MOS transistors to improve performance characteristics of digital IC's.
- CO2.** Analyze Secondary effects of MOSFETs with Ion implanted Channels for VLSI Circuits.
- CO3.** Develop Quasi static Model and Non Quasi static Models for low, medium and high frequencies.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	-	-	-	-	-
<b>CO2</b>	3	-	-	-	-	-
<b>CO3</b>	3	3	-	-	-	-
<b>Course Correlation Mapping</b>	<b>3</b>	<b>3</b>	-	-	-	-

**Correlation Levels:      3: High;      2: Medium;      1: Low**

## COURSE CONTENT

### Module 1: BASIC DEVICE PHYSICS-I:

(10 Periods)

**Two Terminal MOS Transistor:** Flat-band voltage, Potential balance & charge balance, Effect of Gate-substrate voltage on surface condition, Inversion, Small signal capacitance; C-V Characteristics.

**Three Terminal MOS Transistor:** Contacting the inversion layer, Body effect, Regions of inversion, Pinch-off voltage.

### Module 2: BASIC DEVICE PHYSICS-II:

(12 Periods)

**Four Terminal MOS Transistor:** Transistor regions of operation, general charge sheet models, regions of inversion in terms of terminal voltage, strong inversion, weak inversion, moderate inversion, interpolation models, effective mobility, temperature effects, breakdown p-channel MOS FET, enhancement and depletion type, model parameter values, model accuracy.

### Module 3 SECONDARY EFFECTS OF MOSFETs

(10 Periods)

**MOS Transistor with Ion-Implanted Channels:** Enhancement nMOS, Depletion nMOS, Enhancement pMOS.

**Small dimension effects:** Channel length modulation, barrier lowering, two dimensional charge sharing and threshold voltage, punch-through, carrier velocity saturation, hot carrier effects, scaling, effects of surface and drain series resistance, effects due to thin oxides and high doping. Sub threshold regions, Short channel effects.

### Module 4 MOS TRANSISTOR IN DYNAMIC OPERATION

(07 Periods)

Large Signal modeling: Quasi static operation, Terminal currents in Quasi static operation, Evaluation of Charges in Quasi static operation, Transit time under DC conditions, Limitations of Quasi static Model, Non Quasi static Analysis

### Module 5 SMALL SIGNAL MODELING FOR LOW, MEDIUM AND HIGH FREQUENCIES

(06 Periods)

low, Medium frequency small signal model for the intrinsic part, Small signal model for Extrinsic Part, A complete Quasi static Model, Y-Parameter models, Non Quasi static Models.

**Total Periods: 45**

## EXPERIENTIAL LEARNING

1. Develop the Complete symmetric strong inversion model with necessary equations.
2. Summarize the effects due to thin oxides and high doping and effects of surface and Drain Series resistance.
3. Model a 3 terminal MOS structure of n+ region for open circuited, short circuited and With biased voltage.

## **RESOURCES**

### **TEXT BOOKS:**

1. Y. Tsvividis, *Operations and Modeling of the MOS Transistor*, Oxford university Press, 3<sup>rd</sup> edition, 2012.

### **REFERENCE BOOKS:**

1. Trond Ytterdal, Yuhua Cheng and Tor Fjeldly, *Device Modeling for Analog and RF CMOS Circuit Design*, Wiley Publication, 2003.
2. Donald A Neamen and Dhruves Biswas, *Semiconductor Physics and Devices*, Special Indian Edition, 4<sup>th</sup> edition, 2012.

### **VIDEO LECTURES:**

1. <https://archive.nptel.ac.in/courses/117/106/117106033/>
2. <https://www.digimat.in/nptel/courses/video/117106033/L35.html>



## PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22EC202007	EMBEDDED SYSTEMS DESIGN	3	-	3	-	4.5
<b>Pre-Requisite</b>						
<b>Anti-Requisite</b> --						
<b>Co-Requisite</b> --						

**COURSE DESCRIPTION:** This course provides a detailed discussion on MSP430 Architecture; Instruction Set; Programming; On-Chip Resources; Communication with peripherals; Embedded system design approaches.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Analyse MSP430 Architecture, Instruction Set, addressing modes to develop programs for various control applications using Assembly and Embedded C.
- CO2.** Solve Problems by analysing MSP430 On Chip Resources such as Timer, Clock System, Low Power Modes/techniques and Interrupt Structure.
- CO3.** Realize Mixed Signal Processing and Networking Applications, by analysing on-Chip Resources such as Comparator, ADC, Temperature Sensor, PWM and Communication Peripherals.
- CO4.** Analyse Language, IDE Support, Processor IC & Design Technologies, and System Modelling Techniques to capture behaviour of Embedded Prototype using suitable model.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	3	2	2	-	-	-
CO3	3	3	2	-	-	-
CO4	3	2	2			
<b>Course Correlation Mapping</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>

**Correlation Levels:            3: High;            2: Medium;            1: Low**

## **COURSE CONTENT**

### **Module 1: ARCHITECTURE OF MSP430 (09 Periods)**

Embedded Systems – Introduction, MSP430 - Anatomy of microcontroller, Memory, Software, Pin out (MSP430G2553), Functional Block diagram, Memory, CPU, and Memory mapped input and output, Clock generator; Exceptions- Interrupts and Resets.

### **Module 2: PROGRAMMING MSP430 (09 Periods)**

Development Environment, Aspects of C for Embedded Systems, Assembly Language, Register Organization, Addressing Modes, Constant Generator and Emulated Instructions, Instruction Set, Example programs- Light LEDs, Read input from a switch; Automatic Control-Flashing light by delay, use of subroutines and Functions; Basic Clock System, Interrupts and Low Power Modes.

### **Module 3 TIMERS AND MIXED SIGNAL SYSTEMS (09Periods)**

Timers - Watchdog Timer, RTC, Timer\_A, Measurement in capture mode, PWM generation; Mixed Signal Systems- Comparator\_A, ADC10 SAADC –Architecture, operation- Single Conversion, Temperature Sensor on ADC10, DTC in ADC10; ADC12 – Comparison with ADC10.

### **Module 4 COMMUNICATION PERIPHERALS & PROTOCOLS (09 Periods)**

MSP430 Communication Interfaces- USART,USCI, USI; Communication Protocols- SPI, Inter-integrated Circuit Bus, USB, CAN

### **Module 5 EMBEDDED SYSTEM DESIGN (09 Periods)**

Processor Technology, IC Technology, Design Technology, Tradeoffs. Model vs Language, System Modelling – Data Flow Model, FSM, FSMD, HCFSM, PSM, Concurrent Process Model & implementation.

**Total Periods: 45**

## **EXPERIENTIAL LEARNING**

- I. Introduction to MSP430 launch pad and Programming Environment.
- II.
  1. Practice on usage of Instruction Set
  2. Read input from switch and Automatic control/flash LED (software delay).
  3. Interrupts programming example using GPIO.
  4. Configure watchdog timer in watchdog & interval mode.
  5. Configure timer block for signal generation (with given frequency).
  6. Read Temperature of MSP430 with the help of ADC.
  7. Test various Power Down modes in MSP430.
  8. Generation of Pulse Width Modulation.
  9. Use Comparator to compare the signal threshold level.
  10. Speed Control of DC Motor
  11. Master slave communication between MSPs using SPI.
  12. Networking MSPs using Wi-Fi System modelling using FSM.
  13. UML as design tool.
  14. Networks for embedded systems – SPI, I2C in proteus.
  15. Sensors using SPI, State Machines for I2C Communication.

## **RESOURCES**

### **TEXT BOOKS:**

1. John H. Davies, *MSP430 Microcontroller Basics*, Newnes Publications, 1<sup>st</sup> Edition, 2008
2. Santanu Chattopadhyay, *Embedded System Design*, PHI, 2010.
3. Frank Vahid, Tony D. Givargis, *Embedded System Design – A Unified Hardware/Software Introduction*, John Wiley, 2006

### **REFERENCE BOOKS:**

1. Chris Nagy, *Embedded Systems Design using the TI MSP30 Series*, Newnes Publications, 2003.
2. JorgeonStaunstrup, Wayne Wolf, *Hardware/Software Co-design Principles and Practice*, Springer 2009.
3. Patrick R Schamont, *A Practical Introduction to Hardware/Software Co-design*, Springer publications, 2010
4. Raj Kamal, *Embedded systems Architecture, Programming and Design*, Tata McGraw- Hill, 2016.

### **SOFTWARE /TOOLS:**

1. Software: Code Composer Studio, Energia, Proteus
2. Hardware: MSP430 launch pad, Wi-Fi booster pack, Associated accessories

### **VIDEO LECTURES:**

3. <https://nptel.ac.in/courses/108102045>

### **Web Resources:**

1. <https://www.udemy.com/course/embedded-system-design-using-uml-state-machines/>

## PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
<b>22EC201009</b>	<b>IC FABRICATION</b>	3	-	-	-	3
<b>Pre-Requisite</b>	-					
<b>Anti-Requisite</b>	-					
<b>Co-Requisite</b>	-					

**COURSE DESCRIPTION:** This course provides a detailed discussion on Crystal Growth, Wafer Preparation, Epitaxy and Oxidation, Lithography and Reactive Plasma Etching, Deposition, Diffusion, Ion Implantation, Metallization, Analytical, Assembly and Packaging Techniques.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Analyze Wafer preparation methods, oxidation Techniques, Lithography methods, Etching process, Deposition, Diffusion and Ion-Implantation methods for integrated circuit(IC) fabrication.
- CO2.** Select and apply appropriate oxidation Techniques, Lithography methods, Etching process, Deposition, Diffusion and Ion-Implantation methods for integrated circuit(IC) fabrication.
- CO3.** Apply appropriate, metallization films, packaging techniques in IC fabrication.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	-	-	-	-	-
<b>CO2</b>	3	2	1	-	-	-
<b>CO3</b>	3	3	1	-	-	-
<b>Course Correlation Mapping</b>	<b>3</b>	<b>3</b>	<b>1</b>	-	-	-

**Correlation Levels:            3: High;            2: Medium;            1: Low**

## COURSE CONTENT

### **Module 1: Crystal Growth (09 Periods)**

Introduction to Semiconductor Manufacturing and fabrication, Clean Room types and Standards, Electronic grade silicon, Czochralski crystal growing, silicon shaping.

### **Module 2: Epitaxy and Oxidation (09 Periods)**

**Epitaxy:** Vapor-phase epitaxy, Molecular beam epitaxy, Epitaxial Evaluation.

**Oxidation:** Growth mechanism and kinetics; Oxidation Techniques and systems, Oxide properties, Oxidation of polysilicon, Oxidation-Induced defects.

### **Module 3: Lithography and Etching (09 Periods)**

**Lithography:** Optical lithography, Electron lithography, X-ray lithography

**Etching:** Feature size control and Anisotropic Etch mechanisms, Properties of Etch Processes, Reactive plasma etching Techniques and Equipments.

### **Module 4: Deposition, Diffusion and Ion Implantation (09 Periods)**

**Deposition:** Deposition process, Plasma Assisted deposition

**Diffusion:** The Diffusion Process , Mathematical Model for Diffusion, The Diffusion coefficient , Successive Diffusions, Diffusion Systems,

**Ion Implantation:** Implantation Technology, Mathematical Model for Ion Implantation, Selective Implantation, Channeling, Lattice Damage and Annealing, Shallow Implantations.

### **Module 5: Metallization and packaging (09 Periods)**

Metallization applications, Metallization choices, Physical Vapor Deposition, Metal Interconnections and Contact Technology, Silicides and Multilayer-Contact Technology, Copper Interconnects and Damascene Processes, Wafer Thinning and Die Separation, Die Attachment, Wire Bonding, Packages, Yield.

**Total Periods: 45**

## EXPERIENTIAL LEARNING

1. Model the fabrication process flow of NMOS using TCAD tool
2. Model the fabrication process flow of PMOS using TCAD tool
3. Model the fabrication process flow of CMOS using TCAD tool
4. Model the fabrication process flow of PN junction diode using TCAD tool
5. Model the fabrication process flow of BJT junction diode using TCAD tool

## RESOURCES

### **TEXT BOOKS:**

1. S.M. Sze, *VLSI technology*, Tata McGraw-Hill, Second Edition, 2017.
2. R.C. Jaeger, *Introduction to microelectronic fabrication*, Prentice Hall, Second Edition, 2013.

**REFERENCE BOOKS:**

1. Simon M. Sze, Gary S. May, *Fundamentals of Semiconductor Fabrication*, Wiley, 2011

**VIDEO LECTURES:**

1. <https://nptel.ac.in/courses/117106093>

**WEB RESOURCES:**

1. <https://1lib.in/book/2379383/784b53>

## PROGRAM ELECTIVE

<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>S</b>	<b>C</b>
<b>22EC202010</b>	<b>NANO MATERIALS AND NANOTECHNOLOGY</b>	3	-	3	-	4.5
<b>Pre-Requisite</b>	IC Fabrication					
<b>Anti-Requisite</b>	-					
<b>Co-Requisite</b>	-					

### COURSE DESCRIPTION:

This course provides a detailed discussion and hands-on experience on Nanostructures – Classification and Peculiarities, Characterization and Properties of Nanomaterials, Micro Electro-Mechanical Systems (MEMS) & Nano Electro-Mechanical Systems (NEMS), Carbon Nanotubes (CNT) – Properties and Synthesis, Interdisciplinary Applications of Nanomaterials.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1** Understand the peculiarities of Nanostructured materials, their characterization and properties to solve structural, mechanical and electrical problems in manufacturing Nanostructures.
- CO2** Use IC Fabrication techniques to manufacture Micro Electro-Mechanical Systems (MEMS) and Nano Electro-Mechanical Systems (NEMS).
- CO3** Understand carbon nanotube properties and its synthesis for various applications.
- CO4** Apply the properties of nanomaterials by fixing the boundaries in system development in multidisciplinary areas like Automobiles, Biomedical, and Agriculture.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	-	-	-	-	-
<b>CO2</b>	3	2	3	-	-	-
<b>CO3</b>	3	3	-	-	-	-
<b>CO4</b>	3	2	-	-	-	-
<b>Course Correlation Mapping</b>	<b>3</b>	<b>1</b>	<b>1</b>	-	-	-

**Correlation Levels:            3: High;            2: Medium;            1: Low**

## **COURSE CONTENT**

### **Module 1: Nanostructures and Peculiarities of Nanostructured (09 Periods) Materials**

Gleiter's classification of nanostructured materials, Classification of nanostructures by dimensionality, Concept of "surface form engineering" in nanomaterial science, Extended internal surface, Increasing of surface energy and tension, Grain boundaries, Instability of 3D0 NSM due to grain growth.

### **Module 2: Characterization and Properties of Nanomaterials (09 Periods)**

Structural Characterization: X-ray diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Chemical Characterization: Optical spectroscopy, Electron spectroscopy, Ionic spectrometry, Physical Properties of Nanomaterials: Melting points and lattice constants, Mechanical properties, Optical properties Electrical conductivity.

### **Module 3: Micro Electro-Mechanical Systems (MEMS) and Nano (09 Periods) Electro-Mechanical Systems (NEMS)**

Introduction, Fabrication of MEMS and NEMS, Surface micromachining, Bulk Micromachining, Fabrication stages, Deposition, Patterning, Etching.

### **Module 4: Carbon Nanotubes (CNT) (09 Periods)**

CARBON NANOTUBES AND RELATED STRUCTURES: PRODUCTION AND FORMATION  
Introduction-Carbon Nanotube Production-Catalysts-Growth Enhancement-Growth Mechanisms Functionalization-Purification

LAYER-BY-LAYER ASSEMBLY OF MULTIFUNCTIONAL CARBON NANOTUBE THIN FILMS  
Introduction-Structure and Properties of CNTs-Structural Organization in Multilayers of Carbon Nanotubes-Electrical Conductor Applications-Sensor Applications-Fuel Cell Applications Nano-/Microshell LBL Coatings and Biomedical Applications

### **Module 5: Interdisciplinary Arena of Nanomaterials (09 Periods)**

Molecular Electronics and Nanoelectronics, Nanobots, Biological Applications of Nanoparticles, Catalysis by Gold Nanoparticles, Band Gap Engineered Quantum Devices, Nanomechanics Carbon Nanotube Emitters, Photo electrochemical Cells, Photonic Crystals and Plasmon Waveguides.

**Total Periods: 45**



## **EXPERIENTIAL LEARNING**

### **LIST OF EXERCISES:**

1. Compute the Resistance of a Wire using COMSOL 3D Model
2. Compute the Inductance of a Wire using COMSOL 3D Model
3. Compute the Effect of Fringing Fields on Capacitance using COMSOL 3D Model
4. Compute a ZnO nano rods based piezo electric device using COMSOL 3D Model
5. Construct 3D model of MOSFET using COMSOL and verify its results analytically
6. Model a solenoid with spring return using MATLAB
7. Model a semiconductor photovoltaic cell using MATLAB
8. Develop a model using COMSOL and find the Impedance of a Coaxial Cable
9. Design a model of microstrip patch antenna using COMSOL and verify using MATLAB
10. Design and optimize the thickness of thin film deposition in COMSOL

## **RESOURCES**

### **TEXT BOOKS:**

1. A I Gusev and A ARempel, *Nanocrystalline Materials*, Cambridge International Science Publishing, 1<sup>st</sup> Indian edition, 2008.
2. Guozhong Cao and Ying Wang, *Nanostructures and Nanomaterials: Synthesis, Properties, and Applications*, Imperial College Press, 2004.

### **REFERENCE BOOKS:**

1. Bhushan, Bharat, *Springer Handbook of Nanotechnology*, 2<sup>nd</sup> edition, 2006.
2. Pokropivny, Vladimir, RynnoLohmus, Irina Hussainova, Alex Pokropivny, and Sergey Vlassov, *Introduction to nanomaterials and nanotechnology*, Tartu, Estonia: Tartu University Press, 2007
3. Dirk M. Guldi, Nazario Martín, *Carbon Nanotubes and Related Structures: Synthesis, Characterization, Functionalization, and Applications*, Wiley-VCH, March 2010

### **VIDEO LECTURES:**

1. <https://nptel.ac.in/courses/118104008>
2. <https://nptel.ac.in/courses/118102003>
3. [https://onlinecourses.nptel.ac.in/noc21\\_mm38/](https://onlinecourses.nptel.ac.in/noc21_mm38/)

## PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
<b>22EC201013</b>	<b>SYSTEM-ON-CHIP DESIGN</b>	3	-	-	-	3

**Pre-Requisite** Digital CMOS VLSI Design

**Anti-Requisite** -

**Co-Requisite** -

**COURSE DESCRIPTION:** This course provides a detailed discussion on System on Chip Design Process; System level Design Issues; Test Strategies; Macro Design and Verification; Reusable Macros; System on Chip Verification; Communication Architectures for SoCs.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Understand various SoC Design aspects and issues in low power and high speed Implementations.
- CO2.** Analyze the Macro Design Process to solve issues in usage of hard macros and Develop reusable macros for system integration.
- CO3.** Analyze verification methods at system level, block level and Hardware/Software Co-verification to reduce the test time.
- CO4.** Apply various communication architectures to design energy efficient systems.

### CO-PO Mapping Table:

course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	-	-	-	-	-
<b>CO2</b>	3	1	-	-	-	-
<b>CO3</b>	3	2	3	-	-	-
<b>CO4</b>	3	2	3	-	-	-
<b>Course Correlation Mapping</b>	<b>3</b>	<b>1</b>	<b>3</b>	-	-	-

**Correlation Levels:            3: High;            2: Medium;            1: Low**

## **COURSE CONTENT**

### **Module 1: SYSTEM ON CHIP DESIGN PROCESS**

**(08 Periods)**

A canonical SoC Design, SoC Design flow- waterfall vs spiral, top down vs Bottom up. Specification requirement, Types of Specification, System Design process, System level design issues - Soft IP Vs Hard IP, Design for timing closure - Logic design issues, Verification strategy, Onchip buses and interfaces, Design for Low Power, Manufacturing test strategies.

### **Module 2: MACRO DESIGN PROCESS**

**(07 Periods)**

Overview of IP Design, planning and Specification, Macro Design and Verification, Soft Macro Productization, Developing hard macros - Design issues for hard macros, Model Development for Hard Macros. System Integration with reusable Macros.

### **Module 3 SOC VERIFICATION - I**

**(12 Periods)**

Technology Challenges, Verification technology options, Verification methodology, Test bench Creation, Test bench Migration, Verification languages, Verification IP Reuse, Verification approaches, Verification and Device Test, Verification plans, Bluetooth SoC. System level verification – System Design, System Verification. Block level verification – IP Blocks, Block Details of Bluetooth SoC, Lint Checking, Formal Model Checking, Functional Verification/Simulation, Protocol Checking, Directed Random Testing, Code Coverage Analysis.

### **Module 4 SOC VERIFICATION - II**

**(12 Periods)**

Hardware/Software Co-verification- HW/SW Co-verification Environment, Emulation, soft or virtual Prototypes, Co-verification, UART Co-verification, Rapid Prototype Systems, Software Testing. Static netlist verification, Physical Verification and Design Signoff, Introduction to VMM (Verification Methodology Manual), OVM(Open Verification Methodology) and UVM (Universal Verification Methodology).

### **Module 5 DESIGN OF COMMUNICATION ARCHITECTURES FOR SOCS**

**(06 Periods)**

On chip communication architectures, System level analysis for designing communication, Design space exploration, Adaptive communication architectures-Communication architecture tuners. Communication architectures for energy/battery efficient systems. Introduction to bus functional models and bus functional model based verification.

**Total Periods: 45**

## **EXPERIENTIAL LEARNING**

1. Model Bluetooth transceiver using HDL in VLSI CAD Tools.
2. Model Bluetooth SoC IP using HDL in VLSI CAD Tools.
3. Model UVM architecture for testing real time SoCs.

## RESOURCES

### TEXT BOOKS:

1. Michael Keating, Pierre Bricaud, *Reuse Methodology manual for System On A Chip Designs*, Kluwer Academic Publishers, 3rd Edition, 2002.
2. Prakash Rashinkar, Peter Paterson and Leena Singh, *SoC Verification Methodology and Techniques*, Kluwer Academic Publishers, 2002.
3. A.A. Jerraya, W.Wolf, *Multiprocessor Systems-on-chips*, M K Publishers, 2005.

### REFERENCE BOOKS:

1. William K. Lam, *Hardware Design Verification: Simulation and Formal Method based Approaches*, Prentice Hall, 1<sup>st</sup> Edition, 2005.
2. Farzed Nekoogar, Faranak Nekoogar, *From ASICs to SOCs: A Practical Approach*, Prentice Hall PTR, 2003.

### VIDEO LECTURES:

1. <https://nptel.ac.in/courses/108102045/10>
2. <https://nptel.ac.in/courses/106102181/2>
3. <https://nptel.ac.in/courses/108102045/>

### Web Resources:

1. <https://www.ee.ryerson.ca/~courses/coe838/lectures/Intro-SoC.pdf>
2. <https://slideplayer.com/slide/8148235/>
3. <https://www.cerc.utexas.edu/~jaa/soc/lectures/14-2.pdf>
4. [https://www.cs.ccu.edu.tw/~pahsiung/courses/soc/notes/04\\_Verify.pdf](https://www.cs.ccu.edu.tw/~pahsiung/courses/soc/notes/04_Verify.pdf)

## PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
<b>22EC203025</b>	<b>ADVANCED EMBEDDED SYSTEMS</b>	3	-	-	4	4

**Pre-Requisite** Embedded System Design

**Anti-Requisite** --

**Co-Requisite** --

**COURSE DESCRIPTION:** This course provides a detailed discussion on hardware components, Hardware software co-design and firmware design approaches, Architectural features of PIC18 memory map, interrupts and exceptions, Program PIC18 using the various instructions, for different applications.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
- CO2.** Explain the hardware software co-design and firmware design approaches.
- CO3.** Analyze PIC18 Architecture and Instruction Set to develop computing applications.
- CO4.** Develop Programs for PIC18 using ports, timers and associated on Chip resources for Specified Applications.
- CO5.** Design microcomputer based systems with the knowledge of Interfaces and Peripherals of PIC18 to Solve various engineering problems.

### CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
<b>CO1</b>	3	1	-	-	-	-
<b>CO2</b>	3	3	-	-	-	-
<b>CO3</b>	3	3	-	-	-	-
<b>CO4</b>	3	2	3	-	-	-
<b>CO5</b>	3	2	3	1	-	-
<b>Course Correlation Mapping</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>-</b>

**Correlation Levels: 3: High; 2: Medium; 1: Low**

## **COURSE CONTENT**

### **Module 1: Embedded System**

**(09 Periods)**

Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems.

### **Module 2: Hardware software co-design and Firmware design**

**(09 Periods)**

Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging.

### **Module 3 PIC Microcontroller**

**(09 Periods)**

Pin description of PIC18F452 Microcontroller, Architecture of PIC18, register organisation, Memory organisation, Data formatives & Directives, Addressing modes.

### **Module 4 PIC18 Peripherals**

**(09 Periods)**

Instruction set, Basic port structure, Pin description of PIC18F452, Basic Port Structure, I/O port programming; Macros and modules, Structure of Timer 0 & its Programming using Assembly and C, Counter programming, Structure of timers 1, 2 and 3 & their Programming. Basics of communication – Serial/Parallel, RS232 & PIC18 connection to RS232, Serial Port Structure & programming; PIC18 interrupts, Programming timer interrupts, Programming serial interrupts.

### **Module 5 PIC Interrupts and Interfacing**

**(09 Periods)**

Basics of interrupts, CCP, 7 segment LED and LCD interfacing, keyboard interfacing, interfacing ADC, DAC, Interfacing DC motor, stepper motor, PWM using CCP.

**Total Periods: 45**

## **PROJECT BASED LEARNING:**

1. Design a wireless MultiMeter using PIC18F452 Microcontroller.
2. Design a Automatic School Bell system that triggers a bell at predefined time.
3. Using Proteus simulate PWM code for PIC18F452.

## **RESOURCES**

### **TEXT BOOKS:**

1. K. V. Shibu, *Introduction to embedded systems*, TMH education Pvt. Ltd. 2009.
2. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny causey, *PIC Microcontroller and Embedded Systems: Using C and PIC18*, Pearson Education, 2015.

**REFERENCE BOOKS:**

1. Raj Kamal, *Embedded systems*, McGraw Hill Education, Third Edition, 2017
2. Ramesh S. Gaonkar, *Fundamentals of Microcontrollers and Applications in Embedded Systems (With PIC18 Microcontroller Family)*, Penram International, 2010.
3. M Rafiquzzaman, *Microcontroller Theory And Applications With The PIC*, Wiley India Publications, March 2014

**VIDEO LECTURES:**

1. <https://www.udemy.com/course/basics-of-pic18-microcontroller/?src=sac&kw=BASICS+OF+PIC18>
2. <https://www.udemy.com/course/introduction-to-pic18f-microcontroller/?src=sac&kw=PIC18>

**Web Resources:**

1. <http://www.ciebookstore.com/Content/Images/uploaded/PIC18-Study-GuideCIE.pdf>
2. <https://www.electronicwings.com/pic/getting-started-with-pic18f4550-and-mplabx-ide>

## UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22AI201701	BUSINESS ANALYTICS	3	-	-	-	3

**Pre-Requisite** -

**Anti-Requisite** -

**Co-Requisite** -

**COURSE DESCRIPTION:** This course emphasizes on the basic concepts of Business Analytics. It covers the basic excel skills, Excel look up functions for database queries in business analytics. By the end of this course students will acquire basic knowledge to implement statistical methods for performing descriptive, predictive and prescriptive analytics.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Understand the basic concepts and models of Business Analytics
- CO2.** Select Suitable basic excel function to perform analytics on spread sheets.
- CO3.** Apply different statistical techniques and distributions for modeling the data
- CO4.** Develop user-friendly Excel applications by using statistical models for effectiveness decision making.
- CO5.** Analyze the performance of different optimization models used in prescriptive analytics on Binary and Categorical data.

### COURSE CONTENT

#### **Module 1: FOUNDATIONS OF BUSINESS ANALYTICS (9 Periods)**

Introduction, What is Business Analytics, Evolution of Business Analytics, Scope of Business Analytics, Data for Business Analytics, Applications of Business Analytics, Models in Business Analytics, Problem Solving with Analytics.

#### **Module 2: ANALYTICS ON SPREADSHEETS (9 Periods)**

Basic Excel Skills, Excel Functions, Using Excel Lookup Functions for Database Queries, Spreadsheet Add-Ins for Business Analytics.

Visualizing and Exploring Data: Data Visualization, Creating Charts In Microsoft Excel, Other Excel Data Visualization, Statistical Methods For Summarizing Data, Exploring Data Using Pivot tables.

#### **Module 3: DATA MODELING (9Periods)**

Basic concepts of Probability, Random Variables and Probability Distributions, Continuous Probability Distributions.

Statistical Sampling, Estimation population parameters, Sampling Error, Sampling Distributions, Hypothesis Testing, ANOVA, Chi Square Test.

#### **Module 4 Predictive analytics (9 Periods)**

Trend lines And Regression Analysis, Modeling Relationships And Trends In Data, Simple Linear Regression, Multiple Linear Regression, Building Good Regression Models,

Strategies for predictive decision modeling, implementing models on spreadsheets, spreadsheet applications in business analytics, developing user-friendly excel applications, analysing uncertainty and model assumptions, model analysis using analytic solver platform



## Module 5 Prescriptive analytics

(9Periods)

**Linear Models:** Building Linear Models, Implementing Linear Optimization Models On Spreadsheets, Graphical Interpretation Of Linear Optimization, Linear Optimization Models for prediction and Insight.

**Integer Models:** Solving models with Integer Variables, Integer Optimization Models with Binary Numbers

**Decision Analysis:** Formulating Decision Problems, Decision Strategies Without Outcome Probabilities, Decision Trees With Outcome Probabilities, Decision Trees.

**Total Periods: 45**

### EXPERIENTIAL LEARNING

#### 1. Diabetic Prediction:

The National Institute of Diabetes and Digestive and Kidney Diseases has a created a dataset. The objective of the dataset is to diagnostically predict whether or not a patient has diabetes, based on certain diagnostic measurements included in the dataset. Several constraints were placed on the selection of these instances from a larger database. In particular, all patients here are females at least 21 years old of Pima Indian heritage. The datasets consists of several medical predictor variables and one target variable, Outcome. Predictor variables includes the number of pregnancies the patient has had, their BMI, insulin level, age, and so on. Build a machine learning model to accurately predict whether or not the patients in the dataset have diabetes or not?

2. Solve the house price prediction problem using **Linear regression analysis** method. Optimize the parameters of the regression function using gradient descent method.

3. Visualize the decision tree built for solving Heart disease prediction problem and measure the impurity of nodes created via **Decision Tree Analysis**.

Dataset:<https://www.kaggle.com/arviindn/heart-disease-prediction-uci> dataset/data

4. The data set baby boom (Using R) contains data on the births of 44 children in a one-day period at a Brisbane, Australia, hospital. Compute the skew of the wt variable, which records birth weight. Is this variable reasonably symmetric or skewed?

5. Visualize the **Distribution of data** with different feature scaling methods on online news popularity dataset for article word count.

Dataset:<https://www.kaggle.com/datasets/deepakshende/onlinenewspopularity>

#### 6. Human Activity Recognition System:

The human activity recognition system is a classifier model that can identify human fitness activities. To develop this system, you have to use a smart phone dataset, which contains the fitness activity of 30 people which is captured through smart phones. This system will help you to understand the solving procedure of the **Multi-classification problem**.

## **RESOURCES**

### **TEXT BOOKS:**

1. James Evans, *Business Analytics*, Pearson Education, 2nd Edition, 2017.

### **REFERENCE BOOKS:**

1. Marc J.Schniederjans, *Business Analytics*, Pearson Education, 2015
2. Camm, Cochran, *Essentials of Business Analytics*, Cengage learning, 2015

### **VIDEO LECTURES:**

1. <https://nptel.ac.in/courses/110105089>
2. <https://archive.nptel.ac.in/courses/110/107/110107092/>
3. <https://nptel.ac.in/courses/110106050>

### **Web Resources:**

1. <https://www.proschoolonline.com/certification-business-analytics-course/what-is-ba>
2. [https://michael.hahsler.net/SMU/EMIS3309/slides/Evans\\_Analytics2e\\_ppt\\_01.pdf](https://michael.hahsler.net/SMU/EMIS3309/slides/Evans_Analytics2e_ppt_01.pdf)
3. <https://www.guru99.com/business-analyst-tutorial-course.html>

## UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CE201701	DISASTER MANAGEMENT	3	-	-	-	3
Pre-Requisite	-					
Anti-Requisite	-					
Co-Requisite	-					

**COURSE DESCRIPTION:** This course provides a detailed discussion on disaster prone areas in India, repercussions of disasters and hazards, disaster preparedness and management, risk assessment and disaster management.

**COURSE OUTCOMES:** After successful completion of the course, students will be able to:

- CO1.** Analyze the vulnerability of an area to natural and man-made disasters/hazards as per the guidelines to solve complex problems using appropriate techniques ensuring safety, environment and sustainability.
- CO2.** Analyze the causes and impacts of disasters using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability besides communicating effectively in graphical form.
- CO3.** Suggest the preparedness measures using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability.
- CO4.** Analyze the Risk Assessment using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability.
- CO5.** Design disaster management strategies to solve pre, during and post disaster problems using appropriate tools and techniques following the relevant guidelines and latest developments ensuring safety, environment and sustainability besides communicating effectively in graphical form.

### COURSE CONTENT

#### **Module 1: DISASTER PRONE AREAS IN INDIA (09 Periods)**

**Introduction:** Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types And Magnitude.  
**Disaster Prone Areas:** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

#### **Module 2: REPERCUSSIONS OF DISASTERS AND HAZARDS (09 Periods)**

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

#### **Module 3: DISASTER PREPAREDNESS AND MANAGEMENT (11 Periods)**

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

**Module 4: RISK ASSESSMENT****(08 Periods)**

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

**Module 5: DISASTER MANAGEMENT****(08 Periods)**

Disaster management organization and methodology, Disaster management cycle, Disaster management in India – Typical cases and Cost-benefit analysis, Disaster management programs implemented by NGOs and Government of India, Usage of GIS and Remote sensing techniques in disaster management, Leadership and Coordination in Disaster management, Emerging trends in disaster management.

**Total Periods: 45****EXPERIENTIAL LEARNING**

1. Perform hazard assessment and vulnerability analysis for any nearby town/city and prepare a detailed report of possible impacts of various disasters on environment, infrastructure and development.
2. Prepare a detailed report on the causes and effects of Tsunami that was occurred in the year 2004. Also discuss various advancements in Tsunami warning systems.
3. Identify the major causes of urban floods in cities like Chennai, Hyderabad & Mumbai. Also list various mitigation strategies to reduce the impact of floods.
4. Prepare a detailed report on how various man-made activities are directly/indirectly related to the occurrence of landslides that occurred in recent days in India.
5. Visit AP State Disaster Response and Fire Services Department and record about various methods used by them in mitigating disasters and their management.

## RESOURCES

### TEXT BOOKS:

1. Sharma V. K., *Disaster Management*, Medtech Publishing, 2<sup>nd</sup> Edition, 2013.
2. Anand S. Arya, Anup Karanth, and Ankush Agarwal, *Hazards, Disasters and Your Community: A Primer for Parliamentarians*, GOI-UNDP Disaster Risk Management Programme, Government of India, National Disaster Management Division, Ministry of Home Affairs, New Delhi, Version 1.0, 2005

### REFERENCE BOOKS:

1. Donald Hyndman and David Hyndman, *Natural Hazards and Disasters*, Cengage Learning, USA, 5<sup>th</sup> Edition, 2015.
2. *Disaster Management in India*, A Status Report, Ministry of Home Affairs, Govt. of India, May 2011.
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### VIDEO LECTURES:

1. <https://nptel.ac.in/courses/105104183>
2. <https://www.digimat.in/nptel/courses/video/124107010/L01.html>

### Web Resources:

1. <https://egyankosh.ac.in/handle/123456789/25093>
2. <https://www.egyankosh.ac.in/handle/123456789/25912>
3. <https://www.nios.ac.in/media/documents/333courseE/12.pdf>
4. <https://ndmindia.mha.gov.in/images/public-awareness/Primer%20for%20Parliamentarians.pdf>