MANIPAL UNIVERSITY
JAIPUR

Department of Electronics and Communication Engineering

School of Electrical, Electronics and Communication (SEEC) Engineering

Manipal University Jaipur

M.Tech. (VLSI and Embedded System Design)

Course Handout- (2019-20)

HoD

Director, SEEC

Director, DOA

MANIPAL UNIVERSITY
JAIPUR

Department of Electronics and Communication Engineering

School of Electrical, Electronics and Communication (SEEC) Engineering

Manipal University Jaipur

M.Tech. (VLSI and Embedded System Design)

Course Handout- (2019-20)

12.	EC6104	Embedded Systems	1
13.	EC6106	DSD using Verilog	4

HoD Director, SEEC Director, DOA

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication

Department of Electronics & Communication Engineering
Course Hand-out

Embedded Systems | EC 6104 | 4 Credits | 4 0 0 4

Session: August 19 – December 19 | Faculty: Dr Renu Kumawat | Class: Dep. Core (I Sem)

A. Introduction: This course aims at providing the students with the knowledge and understanding of Embedded systems, Operating systems and Real time systems. The course focus in developing related programming skills of the students to make them employable in Embedded & IoT industries.

B. Course Objectives: At the end of the course, students will be able to

[EC 6104.1]. Review the basic concepts of Embedded Systems, Communication Protocols and Real time Operating System.

[EC 6104.2]. Describe the architectures, structural and software requirements of Embedded Systems and their roles in real life applications.

[EC 6104.3]. Design Embedded System's firmware using ARM programming and apply these programming skills for solving various microcontroller-based problems and interfacing different peripheral devices.

[EC 6104.4]. Identify and apply the knowledge of real-time operating systems for real life embedded systems and hence develop the employability skills.

[EC 6104.5]. Investigate the effects and various issues related to real time operating systems like scheduling, deadlock avoidance, inter process communications, etc. in embedded system design.

C. Program Outcomes and Program Specific Outcomes**

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.4]. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	15
	Sessional Exam II	15
	Online Quizzes and Assignments, Activity feedbacks (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home. However, a student is expected to participate and perform these assignments with full zeal since the activity participation by a student will be assessed and marks will be awarded.	

E. Syllabus

Introduction: Overview of embedded systems, embedded system design challenges, common design metrics and optimizing. Survey of different embedded system design technologies & trade-offs. Embedded microcontroller cores, embedded memories, Examples of embedded systems. Architecture for embedded system,

High performance processors: The ARM Design Philosophy, Embedded System Hardware, Embedded System Software. **ARM Processor Fundamentals:** Architecture Revisions, ARM Processor Families, **Introduction to the ARM Instruction Set:** Data Processing Instructions, Branch Instructions, Load-Store Instructions, Software Interrupt Instruction, Program Status Register Instructions, Introduction to the Thumb Instruction Set, ARM Organization and Implementation, with example, **Programming with ARM:** Programming loops, Character coded data, Code conversion, and Arithmetic examples.

Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, Digital signal processing, Subsystem interfacing, interfacing with external systems.

Real time programming languages and operating systems for embedded systems: RTOS requirements, kernel types, scheduling, context switching, latency, inter-task communication and synchronization, Case studies.

F. Text Books

T1. S. Furber, ARM System-on- Chip Architecture, Second Edition, Pearson Education, 2000.
T2. Yifeng Zhu, Embedded Systems with Arm Cortex-M Microcontrollers in Assembly Language and C, E-Man Press LLC; 2nd ed. edition (15 October 2015).
T3. J. R. Gibson, ARM Assembly Language-an Introduction, Dept. of Electrical Engineering and Electronics, The University of Liverpool, 2007.
T4. Frank Vahid, Tony Givargis, "Embedded System Design: A unified Hardware/Software approach", John Wiley and Sons, 1999
T5. Abraham Silberschaltz, Peter Baer Galvin, Greg Gagne ,"Operating System Concepts" , 9th edition, 2013.
T6. Muhammad Ali Mazidi, *ARM Assembly Language Programming Architecture: Volume (ARM books*), MicroDigitalEd.com, 2016.

Reference Books

R1. N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide, Elsevier, 2004.
R2. Jack Ganssle, The Art of Designing Embedded Systems, Elsevier, 1999.
R3. R. Gupta, Co-synthesis of Hardware and Software for Embedded Systems, Kluwer 1995.

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Digital System Design & HDL | EC 6106 | 4 Credits | 4 0 0 4

Session: July 19 – December 19 | Faculty: Dr. Deepika Bansal | Class: Core Subject

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as department elective, targeting students who are interested in industries, research or higher studies in the field of front-end VLSI. The course offers in depth knowledge of advanced design methodologies and practical design approaches for high-performance FPGA applications. Students are expected to have background knowledge of combinatorial and sequential circuit and the use of finite state machines in the design of sequential systems. The students will learn how a Hardware Description Language (HDL) is used to describe and implement hardware. The emphasis is not on the details and syntax of the language, but rather how the language infers hardware. They will see how to simulate and test on hardware and optimise their designs. They will learn about the use of FPGAs in digital design and the full FPGA design flow.

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

[6106.1]. Recall the concepts of sequential circuit and explain the designing of overlapping & non-overlapping sequence.

[6106.2]. Develop the concept of implementation of the description of a sequential logic function with of a finite-state machine with the appropriate combinational and sequential components.

[6106.3]. Choose a particular PLD for particular application and evaluate performance of CPLD, ASIC & FPGA.

[6106.4]. Implementation of Algorithm State Machine charts and designing of digital application using ASM chart.

[6106.5]. Demonstrate Top down and Bottom up approach and use of data path, control path & pipelining with Verilog code.

[6106.6]. Describe the state diagram and behaviour of application-based machines such as vending and TLC to develop the employability skills.

B. SYLLABUS

Review of logic design fundamentals. Design of Synchronous and asynchronous Circuits, Static timing analysis, Meta-stability, Clock issues, Need and design strategies for multi-clock domain designs Introduction to Verilog: variables, constant, operators, delays, test bench, Digital system design options and trade-offs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral modeling, simulation and synthesis. Digital Design Using ROMs, PALs and PLAs , Arithmetic Circuits: BCD Adder, other adders, State

graphs for control circuits, shift and add multiplier, Array multiplier, different multipliers, Binary divider. Introduction to FSM, State equivalence and machine minimization. Fundamental mode model, Flow table, State reduction, Minimal closed covers, Races, Cycles and Hazards. State machine charts, Derivation of SM Charts, Realization of SM Chart, Implementation of Binary Multiplier, dice game controller. Overview of FPGA architectures and technologies, Logic block architecture, Input and Output cell characteristics, clock input, Timing, Power dissipation, Programmable interconnect, Applications.

C. TEXT BOOKS

1. Prakash Rashinkar Peter Paterson & Leena Singh, SoC Verification Methodology and Techniques, Kluwer Academic, 2001.
2. William K. Lam, Design Verification: Simulation and Formal Method based Approaches, Prentice Hall, 2005.
3. Pong P. Chu, FPGA Prototyping By Verilog Examples, John Willy, 2001.
4. Thomas & Moorby's, The Verilog Hardware Description Language, Kluwer Academic, 1998.

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

System Design using FPGA Lab| EC6133| 1 Credits | 0 0 2 1

Session: July 19 – Dec 19 | Faculty: Ms. Neha Singh | Class: M. Tech. I sem Lab course

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as a Lab course in I semester of postgraduation course in VLSI and embedded system design. The course will enable student to implement a digital system with the given specifications. Design of system architecture is done in a top-down approach. Power consumption, area utilization and timing analysis of the designed and implemented circuits is performed. The designed systems are implemented on Field Programmable Gate Array (FPGA). Verilog is used as language for design entry. All basics taught in the class of Digital system design using Verilog is reinforced through Laboratory Exercises.

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

[1633.1]. Develop Verilog models of combinational and sequential logic circuits
[1633.2]. Translate real world problems into digital logic formulations using Verilog for better employability in VLSI industry
[1633.3]. To study how to implement functions in FPGAs
[1633.4]. Estimate the performance factors of the digital system such as delay, area and power

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.4]. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Each lab experiment is evaluated for performance, lab record maintenance and knowledge and viva during the entire semester. The score is scaled to a maximum of **60 marks**.	60
End Term Exam (Summative)	End Term Exam	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Lab sessions (Formative)	A student who misses a class will have to report to the teacher about the absence. He/ She has to perform the experiment issued on the missed date in extra time during the same week. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence for the week. If the student fails to carry out the experiment in the same week, he will be marked absent with zero marks for attendance in evaluation.	
Lab record	The students need to maintain lab-records of the experiment they carry out in the lab. It is expected from the student that he completes the experiment details in the record within the week of issue of the experiment and get it corrected in the next lab-class itself. Delay in submission of work will attract penalty of marks. A separate Lab-notebooks is to be maintained by individual student to take down observations during lab. The students should get their observations approved by faculty.	

E. SYLLABUS

This lab give exposure to simulation & synthesis software using Xilinx Vivado. This lab aims to implement various digital circuit like combination, Sequential, FSM, ASM etc. using Verilog HDL & synthesis. Test benches for various circuits for delays. Use of FPGA boards to synthesis their codes is also a part of this lab.

F. TEXT BOOKS

Not Applicable

G. REFERENCE BOOKS

[I] Pong P. Chu, FPGA Prototyping By Verilog Examples, John Willy, 2001.
[2] Thomas & Moorby's, The Verilog Hardware Description Language, Kluwer Academic, 1998.

H. Lecture Plan:

Lab No.	Name of the experiment	Experiment Outcome	Type of Expt	Corresponding CO	Mode of Assessing the Outcome
1.	Introduction to software	To acquaint students with the software	Hands-on	NA	NA
2.	Design all gates using VHDL.	To design basic logic gates	Simulation	EC6133.1 EC6133.2	Simulation, Viva-Voce
3.	Write VHDL programs for the following circuits, check the wave forms and the hardware generated (a) Half adder (b) Full adder	To design basic combinational circuits	Simulation	EC6133.1 EC6133.2 EC6133.4	Simulation, Viva-Voce
4.	Write VHDL programs for the following circuits, check the wave forms and the hardware generated (a) multiplexer (b) demultiplexer	To design mux and demux	Simulation	EC6133.1 EC6133.2 EC6133.4	Simulation, Viva-Voce
5.	Write VHDL program for encoder and check the wave forms and the hardware generated	To design basic combinational circuits	Simulation	EC6133.1 EC6133.2 EC6133.4	Simulation, Viva-Voce
6.	Write a VHDL program for a decoder and check the wave form and the hardware generated.	To design basic combinational circuits	Simulation	EC6133.1 EC6133.2 EC6133.4	Simulation, Viva-Voce
7.	Write a VHDL program for a Down counter and check the wave forms and the hardware generated.	To design counter circuits	Simulation	EC6133.1 EC6133.2 EC6133.4	Simulation, Viva-Voce
8.	Write a VHDL program for a BCD to GRAY code converter and check the wave forms and the hardware generated.	To design code converter	Simulation	EC6133.1 EC6133.2 EC6133.4	Simulation, Viva-Voce
9.	Write a VHDL program for a T FLIP-FLOP and check the wave forms and the hardware generated.	To design basic sequential circuits	Simulation	EC6133.1 EC6133.2 EC6133.4	Simulation, Viva-Voce
10.	Implement Full Adder using FPGA.	To design basic combinational circuits and implement on hardware	Simulation	EC6133.2 EC6133.3 EC6133.4	Simulation, Viva-Voce
11.	Implement Delay Flip flop using FPGA	To design basic sequential circuits and implement on hardware	Simulation	EC6133.2 EC6133.3 EC6133.4	Simulation, Viva-Voce
12.	Implement BCD to 7 segments Decoder using FPGA.	To design basic combinational circuits and implement on hardware	Simulation	EC6133.2 EC6133.3 EC6133.4	Simulation, Viva-Voce
13.	Implement an Up Counter using FPGA.	To design counter circuit and implement on hardware	Simulation	EC6133.2 EC6133.3 EC6133.4	Simulation, Viva-Voce
14.	Implement 1-bit Comparator using FPGA .	To design a comparator circuits and implement on hardware	Simulation	EC6133.2	Simulation, Viva-Voce

15.	Implement ALU using FPGA.	To design basic combinational circuits and implement on hardware	Simulation	EC6133.1	Simulation, Viva-Voce

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC6133.1	Develop Verilog models of combinational and sequential logic circuits			1	1	3									3	
EC6133.2	Translate real world problems into digital logic formulations using Verilog for better employability in VLSI industry					3									3	
EC6133.3	To study how to implement functions in FPGAs			2		3									3	
EC6133.4	Estimate the performance factors of the digital system such as delay, area and power			2	3	3									3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Probability, Random Variables & Stochastics | **MA6102** | 4 Credits | 4 0 0 4

Session: July-Nov 19 | Faculty: **Dr. Vivek Singh** | Class: **M. Tech** (VLSI & Embedded System Design)

A. **Introduction: M. Tech** (VLSI & Embedded System Design) course is offered by Dept. of Electronics & Communication Engineering, targeting students who wish to pursue in the field of Electronics Engineering or higher studies VLSI & Embedded System Design. This course will enable students to understand the basic concepts of numerical methods relation to computational methods and their applications it also aims to develop understanding about the general methods used to solve the problem of Embedded System Design, drives and analysis efficiency of instruments with its interpretation by using different kind of computational methods using numerical techniques. The course contains a good introduction to each topic at a fairly understandable level to the students at this stage. Each concept has been explained through examples and application-oriented problems.

B. **Course Outcomes:** At the end of the course, students will be able to

[6102.1]. Understand the concept of Statistical methods.
[6102.2]. Apply the conceptual framework of Statistical Inference.
[6102.3]. Understand conceptual framework of Stochastic Processes.
[6102.4]. Understand conceptual framework of Random Processes.
[6102.5]. Understand conceptual framework of Queuing Theory.

C. **PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

[PO.1]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

[PO.4]. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

[PO.5]. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

[PO.6]. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

[PO.9]. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.10]. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

[PO.11]. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

[PO.12]. Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I	20
	Sessional Exam II	20
	In class Quizzes and Assignments, Activity feedbacks (Accumulated and Averaged)	20
End Term Exam (Summative)	End Term Exam	40
	Total	100
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Statistical Methods: Correlation and Regression. **Statistical Inference:** Z-test, t-test, F-test, Chi-square test, Analysis of variance (ANOVA), Parameter Estimation- point and interval. **Stochastic Processes:** Introduction, generating functions, Markov chains, transition probabilities, Chapmen Kolmogorov equations, Classification of states, Chains of Markov process, Stability of Markov systems, limiting behavior. **Random Processes:** Introduction, Special types of Random Processes, Stationary Process, Random Walk, Poisson Process, Derivation of Poisson process, Properties of Poisson process, Related Distributions. **Queuing Theory:** Introduction, general concepts, Birth and Death processes, M/M/1 and M/M/S models and their steady state and transient behavior.

References:

1. K.K. Das and D. Bhattacharjee, A Treatise on Statistical Inference and Distributions, Asian Book Private Limited, 2008.
2. A.M. Natarajan and A. Tamilarasi, Probability, Random Processes and Queuing Theory, New Age International publisher, 2010.

3. J. Medhi, Stochastic Processes, New Age Science, 3rd Edition, 2009. 2. Papoulis & S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw Hill, 2002.
4. P. Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, McGraw Hill International Edition, Singapore, 2001.

F. Lecture Plan:

Lecture No.	Chapter Name	Topics	Corresponding CO
1	**Statistical Methods**	Correlation-I	6102.1
2		Correlation-II	6102.1
3		Correlation-III	6102.1
4		Regression-I	6102.1
5		Regression-II	6102.1
6		Regression-III	6102.1
7	**Statistical Inference**	Z-test-I	6102.2
8		Z-test-II	6102.2
9		t-test-I	6102.2
10		t-test-II	6102.2
11		F-test	6102.2
12		Chi-square test-I	6102.2
13		Chi-square test-II	6102.2
14		Analysis of variance (ANOVA)-I	6102.2
15		Analysis of variance (ANOVA)-II	6102.2
16		Analysis of variance (ANOVA)-III	6102.2
17		Parameter Estimation- point and interval-I	6102.2
18		Parameter Estimation- point and interval-II	6102.2
19		Problem Solving Class	6102.2
20	**Stochastic Processes**	Introduction	6102.3
21		generating functions-I	6102.3
22		generating functions-I	6102.3
23		Problem Solving Class	6102.3
24		Markov chains, transition probabilities,	6102.3
25		Chapmen Kolmogorov equations,	6102.3
26		Classification of states,	6102.3
27		Problem Solving Class	6102.3
28		Chains of Markov process-I	6102.3
29		Chains of Markov process-II	6102.3
30		Stability of Markov systems	6102.3
31		Problem Solving Class	6102.3
32		limiting behaviour	6102.3
33	**Random Processes**	Introduction	6102.4
34		Special types of Random Processes	6102.4
35		Stationary Process	6102.4
36		Problem Solving Class	6102.4
37		Random Walk-I	6102.4
38		Random Walk-II	6102.4
39		Poisson Process, Derivation of Poisson process,	6102.4
40		Properties of Poisson process, Related Distributions.	6102.4
41		Problem Solving Class	6102.4
42	**Queuing Theory**	Introduction,	6102.5
43		general concepts,	6102.5
44		Birth and Death processes	6102.5
45		Problem Solving Class	6102.5
46		M/M/1 and their steady state and transient behaviour.	6102.5
47		M/M/S models and their steady state and transient behaviour.	6102.5
48		Problem Solving Class	6102.5

G. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES							CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3
MA6102.1	Understand the concept of Statistical methods.	2									1
MA6102.2	Understand conceptual framework of Statistical Inference.	2									
MA6102.3	Understand conceptual framework of Stochastic Processes.		2								2
MA6102.4	Understand conceptual framework of Random Processes.		1			1		2			
MA6102.5	Understand conceptual framework of Queuing Theory.	2								2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

VLSI Process Technology | EC 6148 | 3 Credits | 3 0 0 3

Session: July 19 – December 19 | Faculty: Prof. Jamil Akhtar | Class: Program Elective

Introduction: This course comes in the class of program elective for the postgraduates. This offered course is designed to provide basic knowledge of microfabrication process and packaging technology of VLSI devices to the students. This course will also impart the core knowledge about the kinetics and quality measures involved in each stage of VLSI fabrication and gives sufficient knowledge to work in the semiconductor fabrication industry.

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

[6148.1]. To understand the semiconductor materials as basis of solid-state electronic devices and technology and its historical evolutions.
[6148.2]. Able to understand the oxidization process and its quality measures in the fabrication.
[6148.3]. To explain lithography process and its importance in the semiconductor industry and the various techniques.
[6148.4]. To understand other process steps like diffusion, etching, implantation and metallization and their implications.
[6148.5]. To understand the concepts of electrical testing and packaging of ICs enhancing the employability skills in VLSI Domain.

B. SYLLABUS

Material Properties: Physical properties, Crystal structure, Miller indices, Packing Density, Defects, Dislocation. Crystal Growth: Silicon Crystal Growth - Czochralski and Float Zone Technique, Distribution of dopants, Segregation/Distribution coefficient. Silicon Oxidation: Thermal Oxidation process- Kinetics of Growth, Deal-Grove Model, Impurity Distribution, Masking properties. Photolithography: Photo resists, Lift Off technique, Optical Lithography, Next generation lithography .Diffusion: Basic diffusion process- Fick's first and second law, Pre-deposition and drive-in diffusion, Diffusion profile for various dopants, Lateral Diffusion. Ion Implantation: Range, straggle, ion stopping, ion Channeling, RTA. Etching: Wet and dry etching-Plasma fundamentals; Film Deposition: PECVD, and Epitaxy Metallization: evaporation and sputtering; Realizing resistor, capacitor, diode, BJT, MOSFET, CMOS structures, Twin Tub process, High-k Dielectrics, electro-migration. Single and Double Damascene process. IC assembly techniques: Dicing, Bonding and types of packaging & packaging process.

C. TEXT BOOKS

1. S. M. Sze, "VLSI Technology", Second Edition, McGraw Hill, 1988
2. S. K. Gandhi, "VLSI Fabrication Principles", Second Edition, John Wiley & Sons, 1983.
3. S. A. Campbell, "The Science & Engineering of Microelectronic Fabrication", Second Edition, Oxford University Press, 2005.
4. G. S. May & S. M. Sze, "Fundamentals of Semiconductor Fabrication", Wiley Student Edition 2004

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics and Communication Engineering (SEEC)

Department of Electronics and Communication Engineering

Course Hand-out

Seminar | EC 6171 | 1 Credit | 0 0 2 1

Session: Aug 2019 – Nov 2019 | Faculty: Dr. Shilpi Birla | M.Tech. First Year

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

[EC6171.1]. Discuss recent areas in the field of VLSI & Embedded Systems.
[EC6171.2]. To conduct a Literature Review of the suggested topic.
[EC6171.3]. Compare and discuss the several existing solutions for research challenge.
[EC6171.4]. To report and present the findings of the study conducted to enhance the employability skills.

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

Research Methodology (Part-B) | DR6001 | 2 Credits | 2 0 0 2

Session: Jul 19 – Dec 19 | Faculty: Dr. Himanshu Chaudhary| Class: Regular

A. Introduction: This course comes in the class of open electives for the PhD students. This course will cover fundamental concepts used in sampling techniques, various measurement and scaling techniques, mathematical modelling of engineering systems with various engineering optimization techniques and their design of experiments in research design arena. The contents of the course are thoughtfully designed, so that students would able to incorporate these concepts into their research. The concepts of Sampling techniques will be covered first, followed by various measurement and scaling techniques. In summary, this course will provide exposure to theory as well as practical systems and software used in Research Methodology.

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

[6001.1]. Compare and Employ various sampling techniques in research design with examples.

[6001.2]. Classify relevant measurement and scaling techniques of research design in detail with examples.

[6001.3]. Compare, analyse and evaluate various mathematical models and their system simulation with examples.

[6001.4]. Discuss the fundamental concepts of designing of experiment and the analysis of obtained data with examples.

C. Program Outcomes and Program Specific Outcomes

[PO.1]. Engineering knowledge: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. Design/development of solutions: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.4]. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

[PO.5]. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

[PO.6]. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.10]. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

[PO.11]. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

[PO.12]. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Close Book)	10
	Sessional Exam II (Close Book)	10
	In class Quizzes and Activity feedbacks plus case based projects (Accumulated and Averaged)	05
End Term Exam (Summative)	End Term Exam (Close Book)	25
	Total	50
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. SYLLABUS

Sampling Techniques: basic terms, Importance of sampling in research, essentials of a good sample, sampling error, standard error of the mean (Standard Deviation), Estimation of parameters, accuracy & precision of estimation, sampling procedure, types/methods of sampling, Central limit theorem, sample size determination, confidence interval and Confidence level.

Measurement & Scaling Techniques: - types of data: Primary & Secondary, Types of Scales: Ratio, Interval, Ordinal Nominal. Mapping rules, characteristics of a good measurement, sources of error in measurement.

Mathematical modeling of Engineering systems: Basic concepts of modeling of Engineering systems – Static and dynamic model – Model for prediction and its limitations, system simulation using tools like MATLAB, SPSS, Minitab, COMSOL, Ansys etc.- validation, use of optimization techniques – Genetic Algorithm, Simulated Annealing.

Design of Experiments: Basic principles, Study of completely randomized and randomized block design.

F. TEXT BOOKS

1) Stuart Melville and Wayne Guddard, "Research Methodology an introduction for Science & Engineering Students", JUTA Academic, 1996.
2) R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011.

G. REFERENCE BOOKS

1) C. R. Kothari, Gaurav Garg, "Research Methodology: Methods and Techniques", New Age International Publishers, Fourth edition, 2019.
2) Ranjit Kumar, "Research Methodology", Sage Publishing, 4th Ed. Edition, 2014.

H. Lecture Plan:

Lec. No.	Topics	Session Outcome	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1-4	**Sampling Techniques:** basic terms, Importance of sampling in research, essentials of a good sample, sampling procedure, types/methods of sampling, sampling error, standard error of the mean.	Understanding the concept of sampling techniques with their importance in research with examples.	Lecture through PPT/ Board followed by activity	6001.1	In Class Quiz/ Assignments/ Mid Term-01/ End Term/ Class Project
5-10	Estimation of parameters, accuracy & precision of estimation, Central limit theorem, sample size determination, confidence interval and Confidence level.	Understanding the relationship between the shape of the population distribution and the sampling distribution of the mean by the central limit theorem in statistical inference.	Lecture through PPT/ Board followed by activity	6001.1	In Class Quiz/ Assignments/ Mid Term-01/ End Term/ Class Project
11-14	**Measurement & Scaling Techniques:** Types of data: Primary & Secondary, Types of Scales: Ratio, Interval, Ordinal Nominal. Mapping rules, characteristics of a good measurement, sources of error in measurement.	Understanding of the type of data with their scales and mapping rules.	Lecture through PPT/ Board followed by activity	6001.2	In Class Quiz/ Assignments/ Mid Term-02/ End Term/ Class Project
15-20	**Mathematical modelling of Engineering systems:** Basic concepts of modelling of Engineering systems – Static and dynamic model – Model for prediction and its limitations, system simulation using tools like MATLAB, SPSS, Minitab, COMSOL, Ansys etc.- validation, use of optimization techniques – Genetic Algorithm, Simulated Annealing.	Understanding the comparison of various mathematical models and analysis of their system simulation with optimization techniques examples.	Lecture through PPT/ Board followed by activity	6001.3	In Class Quiz/ Assignments/ Mid Term-02/ End Term/ Class Project
21-25	**Design of Experiments:** Basic principles, Study of completely randomized and randomized block design.	Understanding the completely randomized design (CRD) for comparative experiments in research methodology.	Lecture through PPT/ Board followed by activity	6001.4	In Class Quiz/ Assignments/ End Term/ Class Project

MANIPAL UNIVERSITY JAIPUR
School of Electrical, Electronics & Communication Engineering

Department of Electronics & Communication Engineering
Course Hand-out

ADVANCED MICROCOMPUTER SYSTEMS & INTERFACING | EC 6204 | 4 Credits | 4 0 0 4

Session: Jan 20 – May 20 | Faculty: Dr. Neetu Marwah| Class: Core Subject

A. **Introduction:** This course aims to introduce the architecture of microprocessors (8086), 80286, 80386 and 80486. The course incorporates, basic understanding of the device working environment including its basic programming in assembly language. The course gives the conceptual orientation about how programs work, other important parameters involved.

B. **Course Outcomes:** At the end of the course, students will be able to
[EC6204.1]. Classify problems related to the device architectural design and improvised the skill set
[EC6204.2]. Estimate and analyze problems based on the mathematical reasoning, leading to employability
[EC6204.3]. Develop Logical and Conditional programming skills to promote entrepreneurship
[EC6204.4]. Outline the conceptual details of the devices through programming problems.

C. **PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES**

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.4]. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Open Book)	15
	Sessional Exam II (Open Book)	15
	Three Assignments each of 05 marks Two Quizzes each of 05 marks Software based Assignment	30
End Term Exam (Summative)	End Term Exam (Open Book)	40
	Total	100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments for Academic absence in the class.	Students who misses any assessment procedure will have to report to his/her faculty about the absence (with reason). Respective faculty as per the reason will, (with consent of the course coordinator) decide his/her eligibility for the reassessment. Date and time of the reassessment will be informed with prior notice.	
Homework/ Home Assignment/ Activity Assignment (Formative)	This is flipped class room activity. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed at the faculty level and might reflect in the internal marks.	

E. SYLLABUS

8086 Microprocessor: Introduction Microprocessors, Classes of Processors, Pipeline & Replication, Flynn's Taxonomy, Basic Program Execution Model, Programmers Model - 8086,80286,80386,80486, 8086-80486 Instruction Encoding Schemes, Data Transfer Instructions - Data copy, Awapping, Stack Based Operations, Data Manipulation Instructions- Arithmetic & Logic Operations, String Operations, Shift Rotate Operations, Introduction to MASM- Assembler Directives, Program Control Instructions - Branching, Subroutines, Software Interrupts Macro, Pin Out of 8086 Minimum & Maximum Mode of Operation, Memory Organization - Real & Protected Mode, Memory Interfacing & Banking, x86 Interfacing to I/O devices, Buses.

F. TEXT BOOKS

T1. Douglas V Hall, Microprocessor and Interfacing, TMH, (2e), 2010.

G. REFERENCE BOOKS

R1. K. Ray & K. M. Bhurchandi, "Advanced microprocessor and peripherals", TMH 2006.

H. Lecture Plan

Lec. No.	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1,2,3	Overview of Microprocessors & Introduction to 16-bit microprocessors	Students would get acquainted with basic understanding of the microprocessors and its developmental stages.	PPT/ Board followed by activity	NA	NA
4,5,6	8086 Architectural Model overview & its operational details.	Knowledge of architectural view of 8086 & it's working principle.	PPT	6204.1	In Class Quiz Mid Term-01 End Term
7,8,9,10	8086 Memory Segmentation, Memory Address generation, I/O Port addressing (with the help of examples)	Students would be able to understand 8086 memory structure and its operational details.	Lecture	6204.1 & 6204.2	In Home Assignment Mid Term-01 End Term
11,12,13	8086 Minimum and Maximum Mode signals	Understanding of 8086 mode operations & pin details.	Lecture	6204.5	In Class Quiz MidTerm-01 End Term
14,15,16	8086 Instruction set & Addressing modes	Basic Understanding of programming fundamentals.	Lecture	6204.3 & 6204.4	MidTerm-02 End Term
17,18,19	8086 Programming practice	Improvement of Programming skills	Lecture & Self study	6204.3 & 6204.4	MidTerm-02 End Term
20,21	Overview of Microprocessor 80286	Students would get acquainted with basic understanding of the microprocessors and its developmental stages.	PPT	NA	NA
22,23,24	80286 Architectural features	Knowledge of architectural view of 80286 & it's working principle.	PPT	6204.1	In Class Quiz Mid Term-02 End Term
25,26,27	Introduction to 80386	Improvement of analytical skills	Lecture	6204.2,6204.3 & 6204.4	In Class Quiz End Term
28,29,30	80386 Architectural features	Improvement of analytical skills	Lecture	6204.2,6204.3 & 6204.4	End Term
30,31,32	Introduction to 80486	Improvement of analytical skills	Lecture & Self study	6204.2,6204.3 & 6204.4	End Term
33,34	80486 Architectural features	Students would be able to understand the difference between 80486 and 8086	PPT	6204.5	End Term
35,36,37	Comparison of 8086, 80286, 80386 and 80486	Knowledge of various micro processors and its fundamentals	PPT	NA	In Class Quiz
38,39,40	Programming of 8086	Basic Understanding of programming fundamentals.	Lecture	6204.2,6204.3 & 6204.4	End Term
41	Conclusion and Course Summarization	NA	NA	NA	NA

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 6204.1	Classify problems related to the device architectural design and improvised the skill set	3														
EC 6204.2	Estimate problems based on the mathematical reasoning; leading to employability	3	3		2											
EC 6204.3	Develop Logical and Conditional programming skills to promote entrepreneurship	3	3	1	3											
EC 6204.4	Outline the conceptual details of the devices through programming problems; and	3	2	1	3											

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Low Power VLSI Design| EC 6259 | 4 Credits | 4 0 0 4

Session: January 20 – May 20 | Faculty: Dr.Shilpi Birla| Class: Dep. Elective (II Sem,M.Tech)

A. Introduction: This course is offered by Dept. of Electronics & Communication Engineering as an department elective, targeting students who wish to pursue research & development in industries or higher studies in field of Electronics Engineering especially VLSI & Low Power VLSI Design. This course will help the students to understand the concept of VLSI circuit of low power operation, to design various circuits for optimize power. The MOS VLSI Design is the pre-requisite for this course.

B. Course Objectives: At the end of the course, students will be able to

[2258.1] Identify the need of low power design sources of power dissipation and methodologies.
[2258.2] Describe the MOS devices and its parametric effects and various power dissipation.
[2258.3] Examine various low power circuit level reduction techniques
[2258.4] Classify various logic level low power reduction techniques.
[2258.5] Implementation of the low power techniques in designing circuits to enhance the employability skills in VLSI.

Program Outcomes and Program Specific Outcomes

[PO.1]. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.3]. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

[PO.4]. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. Communication: Communicate effectively on complex engineering activities with the engineering

community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

C. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Open Book)	15
	Sessional Exam II (Open Book)	15
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	30
	Laboratory Sessions	
End Term Exam (Summative)	End Term Exam (Open Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

D. Syllabus

Introduction: Need for Low Power VLSI chips, Sources of power dissipation in Digital Integrated circuits. Emerging low power approaches, Hierarchical Low Power Design Methodologies. Device & Technology Impact on Low Power: Physics of power dissipation in CMOS devices; Dynamic and static power dissipation, Transistor sizing & gate oxide thickness; Impact of technology Scaling and Device innovation. Power estimation, Simulation and Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis. Circuit level Power reduction techniques: Power consumption in circuits; Design of Flip Flops and Latches; Low Power Dynamic logic families & adiabatic logic families. Logic level Power reduction techniques: Gate reorganization, pre-computation logic, signal gating, logic encoding, state machine encoding, reduction of power in address and data buses. Low power Architecture and Systems: Power and performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design. Low power Clock Distribution: Power dissipation in clock distribution, Single driver versus Distributed buffers, Zero skew versus Tolerable skew, chip and package co design of clock network. Algorithm and Architectural level Methodologies: Introduction, design flow, Algorithmic level analysis and optimization, Power aware software designs, Architectural level estimation and synthesis.

E. Reference Books

R1: G. K. Yeap, "*Practical Low Power Digital VLSI Design*", KAP, 2002.
R2: Rabaey, Pedram, "*Low power design methodologies*" Kluwer Academic, 1997.
R3:K. Roy, Sharat Prasad, "*Low Power CMOS VLSI Circuit Design*" Wiley, 2000.
R4: Kiat, S. Yeo, W. L. Goh, "*CMOS/BiCMOS ULSI Low Voltage Low Power*", Pearson, 2002.

F. Lecture Plan:

Lecture No	**Topics**	**Session Outcome**	**Mode of Delivery**	**Corresponding CO**	**Mode of Assessing the Outcome**
1	Introduction & Overview of the course	Need of the course	Lecture	NA	NA
2	Need for Low Power design,	Identify the needs of low power circuits in this Electronics world.	Lecture	2258.1	In Class Quiz Mid Term I End Term
3,4,5	Sources of power dissipation in Digital Integrated Circuits-I	Identify different sources of power dissipation in circuits.	Lecture	2258.1	In Class Quiz Mid Term I End Term
6,7	Physics of power dissipation in CMOS devices	Explain the MOS structure and its physics.	Lecture	2258.1	Home Assignment Mid Term I End Term
8,9	Emerging Low Power approaches	Identify new low power approaches.	Lecture	2258.1	In Class Quiz Mid Term I End Term
10	Dynamic Power dissipation	Describe the types of power dissipation in circuits.	Lecture, Activity	2258.2	Class Quiz Mid Term I End Term
11	Static Power Dissipation	Explain the static power dissipation.	Lecture, Activity	2258.2	Home Assignment Class Quiz Mid Term I End term
12	Transistor sizing & gate oxide thickness.	Recall the sizing effect and thickness effect.	Lecture	2258.2	Class Quiz Mid Term I End Term
13	Impact of technology Scaling and Device innovation	Identify the scaling techniques and it's impact	Lecture	2258.2	Class Quiz Mid Term I End Term
14	Numerical Problems	Discussion and analysis of the topics discussed	Activity	2258.1 2258.2	Class Quiz Mid Term I End Term
15,16	Power consumption in circuits.	Identify the power consumption in circuits.	Lecture	2258.2 2258.3	Class Quiz Mid Term I End Term
17,18	Circuit level power reduction techniques	Analyse circuit level power reduction techniques.	Lecture	2258.3	Class Quiz Mid Term I End Term
19,20	Design of Flip Flops and Latches	Describe working of flip flop & latches using low power topologies	Lecture, Activity	2258.3	Class Quiz Mid Term II End Term

21	Dynamic Logic Families	Analyse the dynamic logic families wrt to Power	Lecture	2258.3	Class Quiz Mid Term II End Term
22	Design Problems	Discussion and analysis of the topics discussed	Activity	2258.3	Class Quiz Mid Term II End Term
23	Gate reorganization structure	Describe the effect of gate reorganization structure	Lecture	2258.4	Class Quiz Mid Term II End Term
24,25	Logic Encoding	Illustrate the effect of logic encoding in circuits	Lecture, Activity	2258.4	Class Quiz Mid Term II End Term
26	Encoding Techniques	Explain various coding techniques for low power applications	Lecture, Activity	2258.4	Class Quiz Mid Term II End Term
27	FSM coding	Describe FSM coding which reduces power	Lecture, Activity	2258.4	Class Quiz Mid Term II End Term
28	Numerical Problems	Discussion and analysis of the topics discussed	Activity	2258.4	Class Quiz Mid Term II End Term
29	Reduction of power in address and data bus	Describe power reduction in data bus	Lecture	2258.4	Class Quiz Mid Term II End term
30,31	Switching activity reduction-	Describe how switching activity reduces power	Activity	2258.2 2258.3	Class Quiz Mid Term II End Term
32	Power dissipation in clock distribution	Describe clock distribution scheme to reduce power	Lecture	2258.4	Class Quiz End Term
33	Zero skew versus Tolerable skew	Identify zero skew and tolerable skew	Lecture	2258.5	Class Quiz End Term
34	Single driver versus Distributed buffers	Discuss the role of various buffers in low power circuits	Lecture	2258.5 2258.3	Class Quiz End Term
35	Power and performance management	Discuss the power management system and its performance	Lecture	2258.5 2258.2	Class Quiz End Term
36	Adiabatic Logic Families	Discuss about Adiabatic logic family	Lecture	2258.5 2258.2	Class Quiz End Term
37	Design Problems	Discussion and analysis of the topics discussed	Activity	2258.4	Class Quiz End Term
38	Parallel architecture with voltage reduction	Discuss how Parallel architecture reduces power.	Lecture, Activity	2258.3 2258.5	Class Quiz End Term
39,40	Low power memory design	Discuss low power memory design	Lecture	2258.5 2258.1	Class Quiz End Term

G. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 2258.1	Identify the need of low power design sources of power dissipation and methodologies.	2				1								2		1
EC 2258.2	Describe the MOS devices and its parametric effects and various power dissipation.	1	1		1									2	2	
EC 2258.3	Examine various low power circuit level reduction techniques		1	1										2	2	
EC 2258.4	Classify various logic level low power reduction techniques.		1	1	1									3	2	
EC 2258.5	Implementation of the low power techniques in designing circuits to enhance the employability skills in VLSI.	1	1			1	1			1	1	1	1	2	2	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics & Communication Engineering (SEEC)

Department of Electronics & Communication Engineering
Course Hand-out

Analog CMOS IC Design | EC 6206 | 4 Credits | 4 0 0 4

Session: January 2020 – May 2020 | Faculty: Dr. Lokesh Garg | Class: Core Course

A. **Introduction:** This course is offered by Dept. of Electronics & Communication Engineering as a Core Course, targeting students who wish to pursue research & development in the field of Analog VLSI Design. This course offers in depth knowledge about designing of single stage amplifiers, differential amplifiers, current mirrors and operational amplifiers using MOSFET transistors. Students will be analyse the various performance parameters and trade-off between gain, bandwidth, voltage swing etc. of the Analog circuits. Students are expected to have background knowledge on Analog Electronic for better understanding of the course and this course is a prerequisite for Analog VLSI Design Course.

B. **Course Outcomes:** At the end of the course, students will be able to

[6206.1] Illustrate the basic working, small signal model and small signal parameters of a MOS transistor.
[6206.2] Understand the working and calculate the performance parameters of analog circuit i.e. single stage amplifiers, current mirrors, differential amplifiers, op-amps.
[6206.3] Improve the performance of analog circuits using frequency compensation and feedback amplifiers.
[6206.4] Effect of noise on analog circuits and study of advanced circuits like Data converters, PLLs and Filters.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PROGRAM OUTCOMES

[PO.1]. **Engineering knowledge**: Demonstrate and apply knowledge of Mathematics, Science, and Engineering to classical and recent problems of electronic design & communication system.

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3]. **Design/development of solutions**: Design a component, system, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

[PO.4]. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAM SPECIFIC OUTCOMES

[PSO.1]. An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	15
	Sessional Exam II (Closed Book)	15
	In class Quizzes and Assignments , Activity feedbacks (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Closed Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within two days from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Activity Assignment & Quiz (Formative)	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded. Minimum 6 Quiz will be given.	

E. SYLLABUS

Introduction: MOS FET device I/V characteristics, second order effects, Capacitances, body bias effect, Biasing Styles, MOS small signal Model, NMOS verses PMOS devices. Single Stage

Amplifiers: Basic Concepts, Common-Source Stage, Common-Source Stage with Resistive Load, CS Stage with Diode-Connected Load, Common Drain and gate amplifiers. **Passive and Active Current Mirrors:** Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors, LargeSignal Analysis, Small-Signal Analysis, Common-Mode Properties. **Differential Amplifiers:** Single-Ended and Differential Operation, Basic Differential Pair, Qualitative Analysis ,Quantitative Analysis, Common-Mode Response ,Differential Pair with MOS Loads, Gilbert Cell. **Operational Amplifier:** Half circuits; Single stage OP-AMP; Two stage OP-AMP; High frequency model of a MOS transistor; Common source amplifier frequency response; Pole splitting; Common drain and common gate amplifier frequency responses. **Negative feedback amplifiers:** Statistical Characteristics of Noise, Noise Spectrum, Types of Noise, Thermal Noise, Flicker Noise. Negative feedback amplifiers with one, two, or more poles in feedback; Loop gain and stability criteria; Phase margin; Frequency compensation Voltage-controlled and currentcontrolled voltage sources using an Op-AMP. Introduction to mixed signal, issues & applications like Data converters, filters & PLL.

F. TEXT BOOKS

1) S. B. Razavi, Design of Analog CMOS Integrated Circuits, Tata McGraw-Hill, 2002.

R

G. REFERENCE BOOKS

1) D. A.Johns, Ken Martin, *Analog Integrated Circuit Design*, *Johns Wiley & Sons*, 2002.

2) R. J. Baker, Harry W.Li & David E.Boyce, *CMOS circuit design, Layout, and Simulation*, *IEEE Press, PHI Pvt Ltd*, 1998.

3) P. E. Allen & Douglas R. Holberg , *CMOS Analog Circuit Design*, Second edition, *Oxford University Press*,2004.

H. Lecture Plan:

Lecture No.	*Topic to be Covered.*	*Session Outcome*	*Mode of Delivery*	*Corresponding CO*	*Mode of Assessing the Outcome*
1.	Overview of the Course		Lecture		
2,3	MOS FET device I/V characteristics.	Understanding about Analog systems	Lecture	2259.1	
4,5	second order effects, Capacitances, body bias effect, Biasing Styles,	Understanding about MOS internal structure.	Lecture	2259.1	Quiz Assignment Mid Term I
6,7	MOS Small-Signal Model.	Understanding about MOS internal structure.	Lecture	2259.1	Quiz Assignment Mid Term I End Term
8,9	NMOS versus PMOS Devices.	Understanding about MOS internal structure.	Lecture	2259.1	Quiz Mid Term I End Term
6,7,8	Single-Stage Amplifiers: Basic Concepts, Common-Source Stage, Common-Source Stage with Resistive Load	Amplifier gain analysis	Lecture	2259.2	Quiz Assignment Mid Term I End Term
9,10,11	CS Stage with Diode-Connected Load	Amplifier gain analysis	Lecture	2259.2	Quiz Assignment Mid Term I End Term

12,13	Differential Amplifiers: Single-Ended and Differential Operation, Basic Differential Pair,	Amplifier gain analysis	Lecture	2259.3	Quiz Assignment Mid Term 2 End Term
14,15	Qualitative Analysis ,Quantitative Analysis of differential amplifiers	Differential amplifier analysis in terms of gain, output resistance, voltage swing	Lecture	2259.3	Quiz Assignment Mid Term 2 End Term
16	Common-Mode Response of differential amplifiers	Differential amplifier analysis in terms of gain, output resistance, voltage swing	Lecture	2259.3	Quiz Assignment Mid Term 2 End Term
17,18	Differential Pair with MOS Loads, Gilbert Cell	Differential amplifier analysis in terms of gain, output resistance, voltage swing	Lecture	2259.3	Quiz Assignment Mid Term 2 End Term
19,20	Passive and Active Current Mirrors: Basic Current Mirrors,	Use of current mirrors in amplifier design	Lecture	2259.3	Quiz Assignment End Term
21, 22, 23	Cascode Current Mirrors, Active Current Mirrors, Large-Signal Analysis, Small-Signal Analysis, Common-Mode Properties	Use of current mirrors in amplifier design	Lecture	2259.3	Quiz End Term
24, 25, 26	Frequency Response of Amplifiers: General Considerations, Miller Effect, Association of Poles with Nodes.	Use of current mirrors in amplifier design	Lecture	2259.3 2259.4	End Term

27	Noise: Statistical Characteristics of Noise, Noise Spectrum,	Noise in analog circuits	Lecture	2259.3 2259.4	End Term
28	Types of Noise, Thermal Noise, Flicker Noise.	Noise in analog circuits	Lecture	2259.3 2259.4	End Term
29,30	Feedback, General Considerations, Properties of Feedback Circuits, Types of Amplifiers, Feedback Topologies,	Feedback analysis in amplifiers	Lecture	2259.3 2259.4	End Term
31,32,33	Voltage-Voltage Feedback, Current-Voltage Feedback, Voltage-Current Feedback, Current-Current Feedback.	Feedback analysis in amplifiers	Lecture	2259.3 2259.4	End Term
34,35	Operational Amplifiers, General Considerations, Performance Parameters	Op-amp gain, output resistance, voltage swing calculation	Lecture	2259.3 2259.4	End Term
36,37,38	One-Stage Op Amps, Two-Stage Op Amps.	Op-amp gain, output resistance, voltage swing calculation	Lecture	2259.3 2259.4	End Term
39,40,41, 42, 43	Designing of op-amps considering gain, voltage swing and bandwidth as performance parameters.	Op-amp gain, output resistance, voltage swing calculation	Lecture	2259.3 2259.4	End Term
44,45,46, 47, 48	Frequency compensation of op-amps	Op-amp frequency analysis	Lecture	2259.3 2259.4	End Term

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
[EC6206.1]	Illustrate the basic working, small signal model and small signal parameters of a MOS transistor.	3	3	1	2	1							2	3	2	1
[EC6206.2]	Understand the working and calculate the performance parameters of analog circuit i.e. single stage amplifiers, current mirrors, differential amplifiers, op-amps.	3	2	2	2	2							2	3	2	1
[EC6206.3]	Improve the performance of analog circuits using frequency compensation and feedback amplifiers.	3	2	2	3	2							2	3	2	1
[EC6206.4]	Effect of noise on analog circuits and study of advanced circuits like Data converters, PLLs and Filters.	3	2	1	3	3							2	3	2	1

MANIPAL UNIVERSITY JAIPUR

School of Automobile Mechanical and Mechatronics Engineering

Department of Mechanical Engineering
Course Hand-out

Embedded System Design Lab| EC 6232 | 1 Credits | 0 0 0 2 1

Session: Jan 20 – May 20 | Faculty: Ms. Pallavi Yarde| Class: M.Tech II Sem

A. Introduction: This course is offered by Dept. of Electronics and Communication Engineering as a lab, targeting students who wish to pursue research& development in industries or higher studies in field of Embedded System Design. The hardware includes 8051, PIC and ARM microcontrollers. Embedded systems lab helps the students to enhance their knowledge on architecture, programming and interfacing of various processors and microcontrollers. The features and facilities available in this lab help the students to do their projects and enhance their knowledge on the latest trends and technologies.

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

[EC6232.1]. To do research and develop the embedded systems platform for future applications.
[EC6232.2]. Develop the Assembly and Embedded C Language Programs for ARM and 8051 controllers.
[EC6232.3]. Develop the interfacing programs for ARM and 8051 controllers and I/O devices to improve their programming skill set.
[EC6232.4]. To gain experience in programming languages that are used in current industrial practice to improve employability and entrepreneurship skills.

C. Program Outcomes and Program Specific Outcomes

[PO.1]. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.3]. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

[PO.4]. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

[PSO.1]. An ability to understand the concepts of VLSI and Embedded System and to apply them to various areas like Networks, Signal processing, VLSI, Embedded systems, RTOS, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.

D. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Laboratory Sessions	60
End Term Assesment (Summative)	Lab Exam Performance	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the Practical End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who misses a lab session will have to report to the teacher about the absence. The missed experiment can be performed as a makeup experiment in the next lab session or anytime before the laboratory exam	
Laboratory Guidelines	Students are expected to maintain an observation book and a laboratory record notebook. The experimental data should be noted in the observation book on the day of performance and the same should be transferred to the record notebook before the next lab. No students are allowed to enter the lab without the observation book and record book and attendance will be marked absent	

E. Syllabus

Introducing the architecture 8051 and ARM (Advanced RISC Machine) Microcontrollers, Introduction to 8051 and ARM programming kit and procedure to run an assembly code on it.

Instruction Set of 8051 and ARM microcontrollers and assembly language programming using these instructions.

Branching/conditional branching programming. Interfacing for 8051 and ARM microcontrollers.

F. Reference Books

R1. JHON.F.Wakerly, “Digital Design Principles & Practices” III Edition, Prentice Hall Publishers

R2. Mazidi, 8051 Microcontroller and embedded system design, McGrawHill

G. List of Experiments

1. a. 8051 Microcontroller Programming Introduction
   b. ARM Microcontroller Programming Introduction
2. ARM Assembly Language Programming-I
3. ARM Assembly Language Programming-II
4. Keil Software and Embedded C for 8051 Microcontroller programming
5. Program to Interface 8 Bit LED for 8051 microcontroller and ARM Controller
6. Program to demonstrate Time delay program using built in Timer/Counter feature for 8051 microcontroller
7. Program to Displaying a message in a 2 line x 16 Characters LCD display and verify the result in debug terminal for ARM.
8. Generation of PWM Signal for ARM controller
9. Serial Communication programing for 8051 microcontroller
10. Design Traffic light Controller using ARM microcontroller
11. Interfacing Stepper motor Controller with 8051 microcontroller
12. Program to demonstrate I2C Interface on IDE environment for ARM controller
13. Design of System On Chip platform using Xilinx FPGAs and Embedded Development Kit for ARM controller

H. Lecture Plan:

Lab No	Name of the Experiment	Experiment Outcome	Type of Expt	Corresponding CO	Mode of Assessing the Outcome
0	Introduction to 8051 Microcontroller	To acquaint and clear teachers expectations and understand student expectations	Live Demo	EC6232.1	NA
1	Introduction to 8051 Microcontroller	To acquaint and clear teachers expectations and understand student expectations	Live Demo	EC6232.1	NA
2	ARM Assembly Language Programming-I	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.2	Observational Data, Viva-Voce
3	ARM Assembly Language Programming-II	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.2	Observational Data, Viva-Voce
4	Keil Software and Embedded C for 8051 Microcontroller programming	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.2	Observational Data, Viva-Voce
5	Program to Interface 8 Bit LED for 8051 microcontroller and ARM Controller	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.2, EC6232.3	Observational Data, Viva-Voce
6	Program to demonstrate Time delay program using built in Timer/Counter feature for 8051 microcontroller	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.2, EC6232.3	Observational Data, Viva-Voce
7	Program to Displaying a message in a 2 line x 16 Characters LCD display and verify the result in debug terminal for ARM.	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.2, EC6232.3	Observational Data, Viva-Voce
8	Generation of PWM Signal for ARM controller	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.1, EC6232.2, EC6232.3	Observational Data, Viva-Voce

9.	Serial Communication programing for 8051 microcontroller	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.1, EC6232.2, EC6232.4	Observational Data, Viva-Voce
10.	Design Traffic light Controller using ARM microcontroller	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.1, EC6232.2, EC6232.3	Observational Data, Viva-Voce
11	Interfacing Stepper motor Controller with 8051 microcontroller	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.1, EC6232.2, EC6232.3	Observational Data, Viva-Voce
12	Program to demonstrate I2C Interface on IDE environment for ARM controller	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.1, EC6232.2, EC6232.3, EC6232.4	Observational Data, Viva-Voce
13	Design of System On Chip platform using Xilinx FPGAs and Embedded Development Kit for ARM controller	To understand the instruction set and apply to solve the problem	HandsOn	EC6232.1, EC6232.2, EC6232.3, EC6232.4	Observational Data, Viva-Voce

I. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
EC 6232.1	To do research and develop the embedded systems platform for future applications.	2	1	3	2	1	1							2	2	3
EC 6232.2	Develop the Assembly Language Programs for ARM and 8051 controllers.	2		1	2	1	3							2	1	3

EC 6232.3	Develop the interfacing programs for ARM and 8051 controllers and I/O devices to improve their programming skill set.	3	1	3	2	1	1							3	2	2
EC 6232.4	To gain experience in programming languages that are used in current industrial practice to improve employability and entrepreneurship skills.	3	3	1	2	2	2							1	3	1
	Maximum articulation	3	3	3	2	2	3							3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics and Communication Engineering (SEEC)

Department of Electronics and Communication Engineering

Course Hand-out

Minor Project | EC 6233 | 3 Credits | 0 0 4 2

Session: Jan 2020 – May 2020 | Faculty: Dr. Shilpi Birla | M.Tech. First Year

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

[EC6233.1]. To conduct a Literature Review of the suggested recent topic in the area
[EC6233.2]. Compare and contrast the several existing solutions for research challenge
[EC6233.3]. Demonstrate an ability to work with deadlines and manage the conduct of the research study
[EC6233.4]. To report and present the findings of the study conducted in the preferred domain using recent skills to enhance the employability skills.

MANIPAL UNIVERSITY JAIPUR

School of Electrical, Electronics and Communication Engineering (SEEC)

Department of Electronics and Communication Engineering

Course Hand-out

MEMS | EC6271 | 3 Credits | 3 0 0 3

Session: Jan 2020 – May 2020 | Faculty: Prof. Jamil Akhtar | M.Tech. First Year

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

[EC6271.1]. To Familiarise with the fundamentals, fabrication process and applications of MEMS.
[EC6271.2]. To understand the basic principles of MEMS sensors and actuators.
[EC6271.3]. To illustrate the design considerations of basic MEMS sensors and actuators.
[EC6271.4]. Design the process flow of a basic MEMS device with a fabrication process description.
[EC6271.5]. To correlate the fabrication process through the hands-on activities which will enhance their employability skills.

A. SYLLABUS

Overview of MEMS & Microsystems: MEMS & Microsystems, Typical MEMS and Micro system products features of MEMS, The multidisciplinary nature of Microsystems design and manufacture, Applications of Microsystems in automotive industry, health care industry, aerospace industry, industrial products, consumer products and telecommunications. Scaling Laws in Miniaturization: Introduction to scaling, scaling in geometry, scaling in rigid body dynamics, scaling electrostatic forces, electromagnetic forces, electricity, scaling in fluid mechanics & heat transfer. Transduction Principles in MEMS & Microsystems: Introduction, Micro sensors, thermal radiation, mechanical, magnetic and biosensors, Micro actuation, MEMS with micro actuators. Microsystems Fabrication Process: Introduction, Photolithography, Ion-implantation, diffusion, oxidation, CVD, PVD, etching and materials used for MEMS, Some MEMS fabrication processes surface micro-machining, bulk micromachining, LIGA process, LASER micro machining, MUMPS, FAB-less fabrication. Micro System Design and Modeling: Introduction, Design considerations: Process design, Mechanical design, Modeling using CAD tools: ANSYS / Multiphysics or Intellisuite or MEMS CAD, Features and Design considerations of RF MEMS, Design considerations of Optical MEMS (MOEMS), Design and Modeling: case studies - i) Cantilever beam ii) Micro switches iii) MEMS based SMART antenna in mobile applications for maximum reception of signal in changing communication conditions and iv) MEMS based micro mirror array for control and switching in optical communications. Micro system packaging: Overview of mechanical packaging of microelectronics micro system packaging, Interfaces in micro system packaging, Packaging technologies.

B. REFERENCE BOOKS

1. Tai Ran Hsu, MEMS and Micro Systems: Design and Manufacture, Tata McGraw , 2002.
2. Boca Raton, MEMS and NEMS: Systems, Devices and Structures, CRC Press, 2002.
3. J. W. Gardner and V. K. Vardan, Micro Sensors MEMS and SMART Devices, John Wiley, 2002
4. N. Maluf, Introduction to Micro Mechanical Systems Engineering, Artech House, Norwood, MA, 2000.

MANIPAL UNIVERSITY JAIPUR

SCHOOL OF ELECTRICAL, ELECTRONICS AND COMMUNICATION (SEEC) ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Program Outcomes

[PO.1]. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.3]. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

[PO.4]. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6]. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes

[PSO.1]. An ability to understand the concepts of VLSI and Embedded System and to apply them to various areas like Networks, Signal processing, VLSI, Embedded systems, RTOS, etc.

[PSO.2]. An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.

[PSO.3]. Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.