

Lovely Professional University, Punjab

Course Code	Course Title	Lectures	Tutorials	Practicals	Credits	
ECE318	CMOS VLSI DESIGN	3	0	0	3	
Course Weightage	ATT: 5 CA: 25 MTT: 20 ETT: 50					
Course Focus	EMPLOYABILITY,SKILL DEVELOPMENT,ENTREPRENEURSHIP					

Course Outcomes :Through this course students should be able to

CO1 :: Draw CMOS Logic Circuits and CMOS Transmission gates

CO2 :: Apply static CMOS combinational and sequential logic at the transistor level, including mask layout.

CO3 :: Focus on the greater depth with the operation of MOS and its structure.

CO4 :: Analyze the frequency response of amplifier.

CO5 :: Compose new designs for different logical circuits with MOSFET

CO6 :: Develop in-depth analytical and design capabilities in digital CMOS circuits and chips

	TextBooks (T)		
Sr No	Title	Author	Publisher Name
T-1	CMOS DIGITAL INTEGRATED CIRCUITS	SUNG-MO-KANG & YUSUF LEBLEBICI	MC GRAW HILL

	Reference Books (R)		
Sr No	Title	Author	Publisher Name
R-1	CMOS VLSI DESIGN	NEIL H.E.WESTE ,DAVID HARRIS & AYAN BANERJEE,	PEARSON

Other Reading (OR)	
Sr No	Journals articles as Compulsary reading (specific articles, complete reference)
OR-1	http://media.wiley.com/product_data/excerpt/96/04714986/0471498696.pdf ,

Relevant Websites (RW)		
Sr No	(Web address) (only if relevant to the course)	Salient Features
RW-1	http://www.sp.phy.cam.ac.uk/~SiGe/CMOS.html	CMOS structure
RW-2	www.eecs.wsu.edu/~ee586/Inv_trans_ch.ppt	ppts on cmos chracteristics

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Audio Visual Aids (AV)		
Sr No	(AV aids) (only if relevant to the course)	Salient Features
AV-1	http://www.youtube.com/watch?v=TXvhyvwtRE	Fabrication of CMOS device
AV-2	http://www.youtube.com/watch?v=yr_zMMDFmrM	Working of CMOS inverter circuit
AV-3	http://www.learnerstv.com/video/Free-video-Lecture-6016-Engineering.htm	BiCMOS video lecture

LTP week distribution: (LTP Weeks)	
Weeks before MTE	7
Weeks After MTE	7
Spill Over (Lecture)	7

Detailed Plan For Lectures

Week Number	Lecture Number	Broad Topic(Sub Topic)	Chapters/Sections of Text/reference books	Other Readings, Relevant Websites, Audio Visual Aids, software and Virtual Labs	Lecture Description	Learning Outcomes	Pedagogical Tool Demonstration/ Case Study / Images / animation / ppt etc. Planned	Live Examples
Week 1	Lecture 1	MOS Transistor(Basic Principle of MOS transistor)	T-1		Zero Lecture, Principle of operation of CMOS	CMOS Students will learn about the operation of CMOS transistor	Brainstorming & Discussion	use water analogy
		MOS Transistor(The Metal Oxide Semiconductor (MOS) Structure)	T-1		Principle of operation of CMOS	CMOS Students will learn about the operation of CMOS transistor	Brainstorming & Discussion	use water analogy
	Lecture 2	MOS Transistor(Basic Principle of MOS transistor)	T-1		Zero Lecture, Principle of operation of CMOS	CMOS Students will learn about the operation of CMOS transistor	Brainstorming & Discussion	use water analogy
		MOS Transistor(The Metal Oxide Semiconductor (MOS) Structure)	T-1		Principle of operation of CMOS	CMOS Students will learn about the operation of CMOS transistor	Brainstorming & Discussion	use water analogy

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Week 1	Lecture 3	MOS Transistor(The MOS system under External Bias)	T-1	RW-1	Operation of CMOS with external supply voltage	Students will learn about the behavior of CMOS transistor when external biasing is done	Demonstration of Animated models	use water analogy principle
Week 2	Lecture 4	MOS Transistor(Structure and Operation of MOS Transistor (MOSFET))	T-1 R-1	RW-2	Physical structure of NChannel & P-Channel MOS	Students will know about, how the flow of current takes place from Source to Drain in N-Type & P-Type MOS	Brainstorming & Discussion	
	Lecture 5	MOS Transistor(The Threshold Voltage)	T-1 R-1		Different physical parameters that affects the Threshold Voltage	Students will understand Importance of Threshold Voltage	Discussion	
	Lecture 6	MOS Transistor(MOSFET current-voltage characteristics)	T-1		MOSFET currentvoltage relationship, Gradual Channel approximation	Students will derive the analytical derivation of the MOS current-voltage relationship, The drain current equation	Simulation in Virtual Lab	
Week 3	Lecture 7	MOS Transistor(MOSFET current-voltage characteristics)	T-1		MOSFET currentvoltage relationship, Gradual Channel approximation	Students will derive the analytical derivation of the MOS current-voltage relationship, The drain current equation	Simulation in Virtual Lab	
	Lecture 8	MOS Transistor(Substrate Bias Effect (Body Effect))	T-1		Body effect, substrate bias coefficient	Students will know the operation of MOS transistor with positive source to substrate voltage	Simulation in Virtual Lab	
	Lecture 9	Fabrication of MOSFET and Scaling(MOSFET scaling & small -geometry effects)	T-1		Full Scaling, Constant Voltage Scaling, Short Channel effects , Narrow Channel effect etc.	Students will learn different scaling techniques & their effects	Brainstorming & Discussion	mobile phone size reduction

Week 4	Lecture 10	Fabrication of MOSFET and Scaling(MOSFET Capacitances)	T-1		Oxide related Capacitance, Junction Capacitance	Student will learn to determine the the nature and the amount of parasitic capacitances associated with MOS transistors	Simulation Videos	show thinner and thicker wall effect
	Lecture 11	Fabrication of MOSFET and Scaling(Fabrication process flow)	T-1	AV-1	Basic steps, Fabrication of NMOS transistor, Device Isolation Techniques etc	Students will know about different steps involved in fabrication of CMOS	Video Lecture & Discussion	
		Fabrication of MOSFET and Scaling(The CMOS n-Well process)	T-1	AV-1	Basic steps, Fabrication of NMOS transistor, Device Isolation Techniques etc	Students will know about different steps involved in fabrication of CMOS	Video Lecture & Discussion	
	Lecture 12	Fabrication of MOSFET and Scaling(Layout design rules)	T-1 R-1	OR-1	Basic principles of Layout Design	Student will learn about the designing the layout of CMOS circuits.	Layout Tools	
		Fabrication of MOSFET and Scaling(Full-Custom Masks Layout Design)	T-1 R-1	OR-1	Basic principles of Layout Design	Student will learn about the designing the layout of CMOS circuits.	Layout Tools	
Week 5	Lecture 13	MOS Inverters (Static and Switching Characteristics) (Introduction to static characteristics)	T-1		static Characteristics and Voltage Transfer Characteristics of CMOS	Students will learn about the different parameters effecting the static characteristics of CMOS.	Simulation in Virtual Lab	
		MOS Inverters (Static and Switching Characteristics) (Voltage Transfer Characteristics)	T-1		static Characteristics and Voltage Transfer Characteristics of CMOS	Students will learn about the different parameters effecting the static characteristics of CMOS.	Simulation in Virtual Lab	
	Lecture 14	MOS Inverters (Static and Switching Characteristics) (Noise Immunity & Noise Margin)	T-1 R-1		Parameters effecting the noise, power and area of a CMOS design.	Student will learn about the parameters effecting the perform ability of CMOS design.	Simulation on tool.	
		MOS Inverters (Static and Switching Characteristics) (Power & Area Consideration)	T-1 R-1		Parameters effecting the noise, power and area of a CMOS design.	Student will learn about the parameters effecting the perform ability of CMOS design.	Simulation on tool.	

Week 5	Lecture 15				Test 1			
Week 6	Lecture 16	MOS Inverters (Static and Switching Characteristics) (Resistive-Load Inverter)	T-1		Inverter design with different loads	Students will learn about designing inverters with different loads.	Simulation on tool.	
		MOS Inverters (Static and Switching Characteristics) (Enhancement-Load Inverter)	T-1		Inverter design with different loads	Students will learn about designing inverters with different loads.	Simulation on tool.	
		MOS Inverters (Static and Switching Characteristics) (Depletion-Load Inverter)	T-1		Inverter design with different loads	Students will learn about designing inverters with different loads.	Simulation on tool.	
	Lecture 17	MOS Inverters (Static and Switching Characteristics) (CMOS Inverter)	T-1 R-1	AV-2	Designing and analyzing the CMOS inverter.	Student will learn to design the CMOS inverter and analyze its working based on different parameters.	Simulation on tool.	
	Lecture 18	MOS Inverters (Static and Switching Characteristics) (Delay-Time Definitions)	T-1 R-1	AV-2	Cascaded CMOS inverter stages and derivation of delay expressions	Students will understand the dynamic behaviors of Inverter circuit.	Demonstration of Animated models.	
		MOS Inverters (Static and Switching Characteristics) (Propagation Delay Time)	T-1 R-1	AV-2	Cascaded CMOS inverter stages and derivation of delay expressions	Students will understand the dynamic behaviors of Inverter circuit.	Demonstration of Animated models.	
		MOS Inverters (Static and Switching Characteristics) (Calculation of Delay Times)	T-1 R-1	AV-2	Cascaded CMOS inverter stages and derivation of delay expressions	Students will understand the dynamic behaviors of Inverter circuit.	Demonstration of Animated models.	
		MOS Inverters (Static and Switching Characteristics) (Inverter Design with Delay Constraints)	T-1 R-1	AV-2	Cascaded CMOS inverter stages and derivation of delay expressions	Students will understand the dynamic behaviors of Inverter circuit.	Demonstration of Animated models.	
Week 7	Lecture 19	MOS Inverters (Static and Switching Characteristics) (Delay-Time Definitions)	T-1 R-1	AV-2	Cascaded CMOS inverter stages and derivation of delay expressions	Students will understand the dynamic behaviors of Inverter circuit.	Demonstration of Animated models.	

Week 7	Lecture 19	MOS Inverters (Static and Switching Characteristics) (Propagation Delay Time)	T-1 R-1	AV-2	Cascaded CMOS inverter stages and derivation of delay expressions	Students will understand the dynamic behaviors of Inverter circuit.	Demonstration of Animated models.	
		MOS Inverters (Static and Switching Characteristics) (Calculation of Delay Times)	T-1 R-1	AV-2	Cascaded CMOS inverter stages and derivation of delay expressions	Students will understand the dynamic behaviors of Inverter circuit.	Demonstration of Animated models.	
		MOS Inverters (Static and Switching Characteristics) (Inverter Design with Delay Constraints)	T-1 R-1	AV-2	Cascaded CMOS inverter stages and derivation of delay expressions	Students will understand the dynamic behaviors of Inverter circuit.	Demonstration of Animated models.	
		SPILL OVER						
Week 7	Lecture 20				Spill Over			
	Lecture 21				Spill Over			
		MID-TERM						
Week 8	Lecture 22	Combinational MOS Logic Circuits(CMOS Logic Circuits)	T-1 R-1		CMOS NOR and NAND implementation with layout of logic gates.	Students will understand the basic principle for design & analysis of CMOS combinational circuits	Simulation in Virtual Lab	
	Lecture 23	Combinational MOS Logic Circuits(Complex Logic Circuits)	T-1 R-1		Complex logic gates, Layout of complex logic gates, Stick diagram implementation, Pseudo N-MOS gate, CMOS full adder circuit.	Students will know the realization of complex Boolean functions of multiple input variable.	Logic simulation of circuit using simulation tool.	
	Lecture 24	Combinational MOS Logic Circuits(Complex Logic Circuits)	T-1 R-1		Complex logic gates, Layout of complex logic gates, Stick diagram implementation, Pseudo N-MOS gate, CMOS full adder circuit.	Students will know the realization of complex Boolean functions of multiple input variable.	Logic simulation of circuit using simulation tool.	
Week 9	Lecture 25	Combinational MOS Logic Circuits(Pass Transistor Circuits)	T-1	RW-1 RW-2	PTL, TG implementation, CPL.	Students will know the rules to implement a Boolean function in different techniques.	Logical simulation on simulation tools.	

Week 9	Lecture 25	Combinational MOS Logic Circuits(CMOS Transmission gates)	T-1	RW-1 RW-2	PTL, TG implementation, CPL.	Students will know the rules to implement a Boolean function in different techniques.	Logical simulation on simulation tools.	
	Lecture 26	Combinational MOS Logic Circuits(Pass Transistor Circuits)	T-1	RW-1 RW-2	PTL, TG implementation, CPL.	Students will know the rules to implement a Boolean function in different techniques.	Logical simulation on simulation tools.	
		Combinational MOS Logic Circuits(CMOS Transmission gates)	T-1	RW-1 RW-2	PTL, TG implementation, CPL.	Students will know the rules to implement a Boolean function in different techniques.	Logical simulation on simulation tools.	
	Lecture 27				Test 2			
Week 10	Lecture 28	Sequential MOS Logic Circuits(Behavior of Bi-stable elements)	T-1 R-1		Static behavior of two inverter Bistable element, Time domain behavior of Bistable element .	students will learn that how two back to back connected inverter circuit is called a bistable one.	Brainstorming & Discussion	
	Lecture 29	Sequential MOS Logic Circuits(SR Latch Circuit)	T-1		CMOS SR latch using NAND & NOR gates.	Students will know about the Design of SR Latch using CMOS.	Brainstorming & Discussion	
	Lecture 30	Sequential MOS Logic Circuits(SR Latch Circuit)	T-1		CMOS SR latch using NAND & NOR gates.	Students will know about the Design of SR Latch using CMOS.	Brainstorming & Discussion	
Week 11	Lecture 31	Sequential MOS Logic Circuits(Clocked Latch and Flip-Flop Circuits)	T-1 R-1		Clocked SR latch, Clocked JK latch, Master slave JK flip flop.	Students will know about the Design of different Flip-flop circuits .	Logical Simulation of flip flop design in virtuoso.	
	Lecture 32	Sequential MOS Logic Circuits(Clocked Latch and Flip-Flop Circuits)	T-1 R-1		Clocked SR latch, Clocked JK latch, Master slave JK flip flop.	Students will know about the Design of different Flip-flop circuits .	Logical Simulation of flip flop design in virtuoso.	

Week 11	Lecture 33	Sequential MOS Logic Circuits(Schmitt Trigger Circuit)	T-1 R-1		Schmitt trigger circuit operation.	Students will know, how a schmitt trigger circuit operates in different modes.	Simulation in virtual tool.	
Week 12	Lecture 34	Dynamic and BiCMOS Logic Circuits(Basic Principles of Pass Transistor Circuits)	T-1		CMOS transmission gate logic, Pre-charge Evaluate Logic.	Students will understand to implement different logic styles using CMOS	Brainstorming & Discussion	
	Lecture 35	Dynamic and BiCMOS Logic Circuits(Dynamic CMOS Circuit Techniques)	T-1		CMOS transmission gate logic, Pre-charge Evaluate Logic.	Students will understand to implement different logic styles using CMOS	Brainstorming & Discussion.	
	Lecture 36				Project - Design project			
Week 13	Lecture 37	Dynamic and BiCMOS Logic Circuits(High-Performance Dynamic CMOS)	T-1 R-1		Domino CMOS logic.	Students will know to design a reliable, High speed, compact circuits using least complicated clock.	Logical Simulation on tool.	
	Lecture 38	Dynamic and BiCMOS Logic Circuits(BJT Structure & Operation)	T-1 R-1	AV-3	BJT operation, current voltage model, Forward active mode, reverse active mode, cut-off mode, saturation mode.	Students will understand the operation of BJT under different bias conditions.	Brainstorming & Discussion	
	Lecture 39	Dynamic and BiCMOS Logic Circuits(Basic BiCMOS Circuit Behavior)	T-1 R-1	AV-3	Dynamic behavior, Charge control model, Static behavior.	Students will learn the operation of BJT with transient terminal voltage condition.	Simulation on virtual tool.	
Week 14	Lecture 40	Dynamic and BiCMOS Logic Circuits(Switching Delay)	T-1 R-1	AV-3	Pull up & Pull down delay analysis.	Students will understand the effect of Pull up & Pull down circuits in a BiCMOS circuits.	Simulations on virtual tool.	
SPILL OVER								
Week 14	Lecture 41				Spill Over			
	Lecture 42				Spill Over			
Week 15	Lecture 43				Spill Over			
	Lecture 44				Spill Over			

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Week 15	Lecture 45			Spill Over			
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Scheme for CA:

CA Category of this Course Code is:A0203 (2 best out of 3)

Component	Weightage (%)	Mapped CO(s)
Test 2	50	
Project - Design project	50	
Test 1	50	

Details of Academic Task(s)

Academic Task	Objective	Detail of Academic Task	Nature of Academic Task (group/individuals)	Academic Task Mode	Marks	Allottment / submission Week
Test 2	To chaeck the students understanding with CMOS applications	Written examination with questions.	Individual	Online	30	10 / 11
Project - Design project	To check students ability to apply the CMOS Transisters for developing systems.	Individual students will develop project using Cadence Tool for real time applications	Individual	Online	30	3 / 13
Test 1	To check the students knowledge about the CMOS Transisters	Written examination with questions .	Individual	Online	30	4 / 5

MOOCs/ Certification etc. not-mapped with the Academic Task(s) (Available for students for better learning/ will get students ready for)

Name Of Certification/Online Course/Test/Competition mapped	Type	Offered By Organisation
DIGITAL ELECTRONIC CIRCUITS	MOOCs	IIT KGP

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