Integral University, Lucknow

Effective from Session:							
Course Code	EC301	**Title of the Course**	Computer Organization and Architecture	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	VI	**3**	**1**	**-**	**4**
Pre-Requisite	Digital Elex	**Co-requisite**					
Course Objectives	**Computer Systems functionality and the interface**						

Course Outcomes	
CO1	Students shall be able to **understand** the Classification and performance evaluation, implementation of memory, and caches, ALU implementation, micro-macro programming, control and I/O interfaces.
CO2	The student shall be able to **understand** the concepts of computer arithmatic operations, ALU and Control unit design, Instruction set.
CO3	The students will be able to **design** the ALU, Control unit design, Instruction set. They will also gain higher concepts of Cache/ Memory organizations, DMA and virtual memory.
CO4	The students will be able to **understand** the importance of systems of memories, programmed I/O and interface to the out-side world.
CO5	The students here will learn an overview of OS, Embedded systems, Microco trollers, other vital aspects of systems like ARM & RAID.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**COMPUTER BASICS**	Int. to Functional Units of Computer, Basic operational concepts of various units, Bus functions and bus architecture, Von Newman model of computing machines, various subsystems, Error Handling and encoding, Parity and parity mechanism, CRC and Hamming Codes, Error detection and correction using codes.	8	CO1
2	**COMPUTER ARITHMATICS**	Int. CPU Block diagram details, Arithmetic and Logic Unit (ALU), Integer Representation, Integer Arithmetic, Floating- Point Representation, Floating Point Arithmetic (add, multiply and subtraction). Central Processing Unit: CPU organization, Instruction set, formats, types, Addressing modes, and operations, Control unit: H/W & Micro programmed control unit.	8	CO2
3	**CAVHE MEMORY**	Computer Memory System Overview, Cache Memory Cache Principles, Elements of Cache Design, Cache organizations, Pentium 4 Cache Organization, Architecture reference manual (ARM) Cache Organization. Internal Memory Technology: Semiconductor Memory, Error Correction, Advanced DRAM Organization. **CO.3**	8	CO3
4	**EXTERNAL MEMORY**	Magnetic Disk, Redundant array of independent disks (RAID), Optical Memory, Magnetic Tape. Input / Output: External Devices, I/O Modules, Programmed I/O, Interrupt Driven I/O, Direct Memory Access (DMA), I/O Channels and Processors, External Interface.	8	CO4
5	**OPERATING SYSTEM SUPPORT**	Operating System overview, Types, Scheduling, Memory Management, Pentium Memory Management, ARM Memory Management. Embedded Systems: Examples of Embedded Systems, Microcontrollers Chips, Microcontrollers Embedded Applications, , A simple Microcontroller example.	8	CO5

Reference Books:

1. William Stallings, “Computer Organization and Architecture”. Eighth Edition, Pearson
2. J. P. Hayes, “Computer Architecture and organization”, MC Graw Hill

3. Carl Hamacher, ZvonkoVranesic, SafwatZaky, NaraigManjikian, “Computer Organization and Embedded Systems”.Sixth Edition, McGraw Hill.
4. Harvey G. Cragon,”Memory System and Pipelined processors”; Narosa Publication.
5. R. K. Ghose, RajanMoona&Phalguni Gupta, “Foundation of Parallel Processing”; Narosa Publications.
6. Kai Hwang and Zu, “Scalable Parallel Computers Architecture”; MGH.
7. V.Rajaranam & C.S.R.Murthy, “Parallel computer”; PHI.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	**3**	**2**	**2**	**1**	**2**	**2**	**1**	**2**				**1**	**1**	**2**	**2**	**2**	**1**	**1**
CO2	**3**	**3**	**3**	**2**	**1**	**1**			**1**			**2**	**2**	**1**	**2**	**2**	**3**	**2**
CO3	**3**	**3**	**3**	**2**	**1**	**1**			**1**				**3**	**2**	**3**	**2**	**3**	**2**
CO4	**3**	**3**	**2**	**2**				**2**					**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**2**	**2**					**1**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC302	**Title of the Course**	**INTEGRATED CIRCUITS**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	Electronics Devices and Circuits	**Co-requisite**					
Course Objectives	• To understand the basic concepts of the circuit configuration for the design of linear integrated circuits and develops skill to solve engineering problems. • Perform signal amplification through BJT and MOS and learn the emitter resistance in differential amplifier replaced by constant current source. • To understand the concept of MOSFET and apply the same to understand the MOS characteristics and model various MOS based circuits. • To understand and develop analytical capability to analyze feedback in amplifiers and apply it to check the stability of feedback amplifiers and analyze multistage and tuned amplifiers. • To understand the concept of Oscillators and analyze the working of different oscillators. To study the concept of regulated power supply and study various circuits for generating regulated power supply.						

Course Outcomes	
CO1	To understand the basic concepts of the circuit configuration for the design of linear integrated circuits and develops skill to solve engineering problems
CO2	Perform signal amplification through BJT and MOS and learn the emitter resistance in differential amplifier replaced by constant current source.
CO3	Student will be able to design mathematical operation using op-amp and OTA.
CO4	Student will be able to design analog multipliers circuit and perform multiplication and division operation and generate the square waveform using Multivibrators.
CO5	Student will be able to design the logic gates using TTL,ECL and IIL.Student will be able to design the power supply circuit.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Review of Basic Integrated Circuits	Bipolar, NMOS, CMOS and BiCMOS, use of composite structure, cross-section, layout and equivalent circuit for Darlington pair, Differential pair, Multimeter and Multicollector for BJT.	**8**	**CO.1**
2	Mirror Curents	BJT and MOS single stage analog amplifiers, differential amplifiers current mirrors and active loads, Widlar,cascaded and Wilson current source, current sources as active loads, Multistage amplifiers, gain and frequency response of the Diiferential amplifier and other characteristics	**8**	**CO.2**
3	Operational Tran conductance Amplifier (OTA)	BJT Operational Amplifier, DC analysis and AC analysis of the 741 Op Amp, gain and frequency response, slew rate. Two satge MOS operational amplifier, CMOS Op Amp design, Folded-Cascade load. IC Operational Tranconductance Amplifier (OTA) using BJT and MOS, Applications of Op Amp and OTA, Active Filters.	**8**	**CO.3**
4	Multipliers	Analog Multiplier with BJT Gilbert Multiplier (GM) cell. GM cell as a Balanced Modulator and Phase detector. Analog Multiplier using NMOS/CMOS devices, Voltage Controlled Oscillator, ICPLL 560,565, BJT/CMOS Bistable Multivibrators and Schmitt Trigger. BJT/CMOS Monostable and Astable circuits, crystal controlled square wave generators, IC Timer (555) as a Monostable, Asatable Multivibrators.	**8**	**CO.4**
5	Logic Families	Formation of basic logic gates (TTL,ECL,IIL)and study of their input-output characteristics, interfacing between logic families . Data converter ICs, Sample and Hold circuit, IC Voltage Regulators, Circuit analysis of 723 and 78/79.	**8**	**CO.5**

Reference Books:

1. Gray, Ilurst, Lewis & Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley.
2. B.Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill.
e-Learning Source:
1. **https://nptel.ac.in**
2. **www.youtube.com**

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2									1	1	2	2			
CO2	3	3	3										3		2	2		
CO3	3	3	3	3	1							1		2	1	3		
CO4	3	3	3	2					1					2	1	3		
CO5	3	3	2	2		1			1				2	2	1			

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	EC303	**Title of the Course**	**Communication System Engineering**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	Electromagnetic Field Theory EC202	**Co-requisite**					
Course Objectives	• **Knowledge about the theory of probability, random process, and optimum detection** • **Knowledge about the noise and its effects on the performance of receiver** • **Knowledge about principles and techniques of analog and digital communication systems** • **Knowledge in various methods of analog and digital modulation/demodulation techniques**						

Course Outcomes	
CO1	Understand different types of modulation and demodulation
CO2	Student learn the theory of probability, random variables, and understand the effect of noise in the communication systems
CO3	Understand different pulse modulation and demodulation techniques
CO4	Understand the basics of information theory, source coding techniques, calculate Entropy of source and efficiency of source coder
CO5	Understand the methods to mitigate inter symbol interference

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Random Process, Random variable & Amplitude Modulation	Random Process & Random variable, correlation function (auto & cross), cumulative distribution function, probability function, joint cumulative & distributive and probability density functions. Elements of Communication Systems, Need of modulation and applications, Amplitude Modulation: Baseband and carrier communication, DSB, SSB, VSB and AM, calculation of BW, modulation index and power, AM Transmitter and Receiver: Balanced modulator, Ring modulator, Carrier Acquisition, Super-heterodyne receiver	8	CO1
2	Angle Modulation	Types of angle modulation, mathematical representation of FM, frequency spectrum of FM wave, Carson Rule, WBFM, NBFM, Phase modulation. Generation of FM: Direct method, stabilized reactance modulator method, indirect method. FM Receivers: Amplitude limiting, Basic FM Demodulators, Ratio Detector, Pre-emphasis & De-emphasis, Comparison of AM & FM	8	CO2
3	Noise	External noise; Atmospheric, Extraterrestrial, Industrial noise. Internal Noise: Thermal agitation, Shot, Transit-time noise. Addition of noise due to several sources, Addition of noise due to several Amplifiers in cascade, Noise in Reactive Circuits. Noise Figure: S/N Ratio, Definition of Noise Figure, Calculation of Noise Resistance, Noise temperature, Noise Performance of CW System: Noise in AM, FM & PM	8	CO3
4	Pulse Communication	Review of sampling process, Pulse Amplitude modulation (PAM) and its spectral analysis, Pulse Width modulation (PWM), Pulse Position modulation (PPM); Modulation and Demodulation; effects of noise. Element Of Digital Communication And Information Theory: Model of a Digital Communication System, Uncertainty, Information, Entropy, Source Coding theorem, Prefix coding, Shannon-Fanno, Huffman Coding, Channel Coding Theorem, Discrete memory less channel, Channel Capacity Theorem.	8	CO4
5	Waveform Coding Techniques	Pulse Code modulation, Quantization noise and signal to noise ratio, Robust quantization: non uniform quantizer, A-law, μ-law companding, differential pulse code modulation (DPCM), adaptive DPCM, delta modulation(DM): idling noise and slope overload, adaptive delta modulation(ADM), Discrete PAM signals : Line Coding and Its Properties, and their Power Spectra (No Derivation) Inter symbol interference, Nyquist Criterion for distortion-less baseband binary transmission, Raised Cosine Spectrum, Correlation receiver, Matched Filter Receiver, maximum likelyhood estimation.	8	CO5

Reference Books:

1. Simon Haykin, Communication System, Wiley India
2. BP Lathi, Modern Analog Digital communication, Oxford University Press India
3. Haykin Simon, Digital Communication Systems, 2005 reprint, John Wiley & Sons India
4. Taub & Schilling, Principles of communication System, McGraw-Hill

5.Bernard Sklar, Digital Communications: Fundamentals & Applications, Second Edition, Pearson Education
6. J. F. Kennedy, Electronic communication System, McGraw-Hill
7. Singh & Sapre, Analog Digital communication Systems, McGraw-Hill

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	1	2	1	1	-	-	-	-	1	3	2	-	1	-	-
CO2	3	3	1	2	2	1	-	-	-	-	-	-	3	-	-	-	-	-
CO3	3	3	2	2	2	1	-	-	-	-	-	-	3	2	-	-	-	-
CO4	3	3	2	1	2	-	-	-	-	-	-	1	3	-	-	1	-	-
CO5	3	3	2	2	2	1	1	1	-	-	-	1	3	2	-	1	-	-

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC304	**Title of the Course**	Automatic Control System	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	Mathematics, Basic Electrical Engineering	**Co-requisite**					
Course Objectives	❖ To understand the concepts of control system and their applications. To provide a systematic approach to interpret different physical systems, mechanical systems and electrical systems and construct the equivalent electrical model of mechanical system. To learn about the representation of a system by transfer function, block reduction method and signal flow graph. ❖ To learn the analysis of a system in time domain and predict the transient performance parameters of a system for different standard inputs. To understand the basic concepts of different types of controllers. ❖ To learn the analysis of a system in frequency domain by Polar Plots, Nyquist Plot and Bode Plot. To study the stability of the system with location of Poles and Zeros and study the stability by using Routh Hurwitz Criterion. ❖ To understand the concept of compensation and design the suitable compensator to make the system stable by Bode Plot and Root Locus Method. ❖ To understand the concepts of state variables and its application for determining the future behavior of a system. To understand the basics of Digital Control system.						

Course Outcomes	
CO1	Given a system, students shall be able to **represent** the system in mathematical form, **identify** type of the system**, apply** block reduction technique and Mason's Gain formula to obtain the transfer function of the given system, and **formulate** differential equation to represent the model of a mechanical system into equivalent electrical system and **solve** using Laplace transform.
CO2	For a given system, **student** shall be able to **analyze** and **evaluate** the system in time domain and **predict** the performance in time domain for different standard input signals. **Evaluate** the steady-state error.
CO3	For a given system, student shall be able to **analyze** the system in frequency domain and explain the nature of stability. **Examine** and **analyze** the stability by Nyquist criterion and Bode Plot.
CO4	For a given unstable system, students shall be able to **identify** and **select** the suitable compensator. To make the system stable **select** and **design** the suitable compensator for implementation. To **develop** the compensator by using Bode Plot and Root Locus.
CO5	For a given a system, student shall be able to find the mathematical model called state-space representation and will be able to **understand** the conversion between transfer function and state-space model. **Solve** the system to find the time response from state-space representation. **Analyze** the system and obtained the transfer function from state-space model and vice versa.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Control Systems**	Basic idea of control systems and their classification. Transfer function of Electrical, Mechanical systems, Feedback and its effect, Mathematical Models of Physical Systems, Analogous Systems, Block Diagram, Signal Flow Graph and Mason's Gain Formula.	8	1
2	**Time Domain Analysis**	Type and order of the system-Typical Test Signals for the Time response of control system-Unit Step, unit ramp and unit impulse- response of first and second order systems – static and dynamic error coefficients-Basic ideas of Proportional, Derivative, Integral and PID Controllers, Study of electronic controllers.	8	2
3	**Stability and Frequency**	Concept of stability, Asymptotic and conditional Stability, Routh Hurwitz criterion, Root locus-Basic Theory and Properties of Root locus –	8	3

	Domain Analysis	Procedure for construction of Root loci. Frequency Domain Analysis- Frequency Response – Frequency Domain Specifications, Correlation between Time and Frequency Response, Polar Plot, Bode Plot, Nyquist Stability Criterion, M and N circle.		
4	**Design through Compensation Technique**	Compensation Techniques – Lag compensator – Lead compensator – Lag Lead compensator, Design of Closed Loop Control System using Root Locus and Bode Pot Compensator.	8	4
5	**State Variable Analysis**	Introduction, State Space Representation, State Models of Linear Systems, State Equations, State Transfer Matrices, Controllability and Observability. Introduction to digital control Systems, Digital/ Discrete Time System, Linear Discrete System, Difference Equation, Role of z transform in discrete time system.	8	5

Reference Books:

1. B.C Kuo, Automatic Control System, PHI
2. Katsuhiko Ogata, Modern Control Engineering, PHI
3. I.J.Nagrath & M.Gopal, Control System Engineering, New Age International Publisher
4. S.K. Bhattacharya, Control System Engineering, Pearson Education.
5. S. Hasan Saeed, Automatic Control System, Kataria and sons, New Delhi

e-Learning Source:

https://www.youtube.com/@s.h.tutorials

https://onlinecourses.nptel.ac.in/noc19_de04/preview

https://www.youtube.com/watch?v=RcuGxWc0HyQ

https://www.youtube.com/watch?v=XMfH2P2Fc6Q

https://nptel.ac.in/courses/107106081

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1	1	1		1	1			1	3	3	2	1
CO2	3	3	3	2	1	1			1			1	3	3	2	1
CO3	3	3	3	2	1	1			1				3	3	2	1
CO4	3	3	3	2	1				2				3	3	2	1
CO5	3	3	2	2					1				3	3	2	1

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	**EC305**	**Title of the Course**	**Antenna & Wave Propagation**	**L**	**T**	**P**	**C**
Year	**3**	**Semester**	5	2	1	0	3
Pre-Requisite	NA	**Co-requisite**	NA				
Course Objectives	➢ To understand the concept of radiation, antenna definitions and significance of antenna parameters and derivation and analysis of radiation characteristics of Hertzian dipole antennas. ➢ To understand the concept of uniform and non uniform arrays, radiation pattern of endfire , broadside, collinear and parasitic array and derivation and analysis of Array Factor ,HPBW and BWFN of antenna arrays. ➢ To understand the concept of Pattern multiplication, Binomial Array, Antenna Top Loading and tuning. ➢ To analyze the characteristics of Traveling wave antenna, rhombic antenna, Folded dipole and Yagi- Uda antenna, Corner reflector , Helical frequency independent, Log periodic Antenna, Microwave Antennas, Parabolic reflector, feed systems and Lens Antennas. ➢ To define and distinguish between different phenomenon of wave propagation (ground wave, space wave and sky wave), understanding and derivation of critical frequency, Skip distance, Maximum Usable Frequency, Duct Propagation and Multi-Hop Propagation.						

Course Outcomes	
CO1	Student will have the depth knowledge of principle of electromagnetic radiation , antenna characteristics, parameters and will be able to deduce the electric fields and magnetic fields radiated by a alternating current element /Hertzian dipole antenna.
CO2	Student will be able to understand and design the concept of antenna array and will be able to do the analyze /recognize the radiation pattern.
CO3	Student will able to understand, classify and design the different types of practical antennas .
CO4	Student will able to understand and analyze the different type of radio propagation and their effects in atmosphere.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Electromagnetic Field Radiation and Antenna Terminology	Electromagnetic Field Radiation: Radiation from an oscillating current element, short monopole and dipole, half wave dipole, Radiation Pattern, Power Radiated, Radiation Resistance. Antenna Terminology : Antenna theorems, Supervisions, Reciprocity, Isotropic Radiator, Directive gain, Power Gain, Efficiency, Effective Area, Effective Length, Bandwidth, Beam width & Polarization, Directional pattern, Directivities, Effective Length Antenna Impedance.	8	1
2	Antenna Arrays and Practical Antenna	Antenna Arrays: Uniform Linear Arrays, Broad side, End fire, Collinear, Parasitic arrays, Binomial arrays, Pattern multiplication. Practical Antenna: VLF, LF, & MF Transmitting antennas, Vertical Radiator, Effect of ground, Grounded Antennas, Grounding systems, Effect of Antenna Height, Antenna Top Loading and tuning, Antenna Array in MF Band. Antenna coupling at medium frequency.	8	2
3	Types of Antenna	Traveling wave antenna, long wire Harmonic antennas, rhombic antenna, VLF & UHF Antenna: Folded dipole, Yagi- Uda, Corner reflector, Helical frequency independent, Log-periodic Antenna, Microwave Antennas, Parabolic reflector, feed systems and Lens Antennas.	8	3
4	Radio wave Propagation	Modes of radio wave propagation: Ground wave & surface Wave Propagation, Effect of Earth & Terrain, Troposphere, ionosphere propagation, Structure of ionosphere, Sky wave propagation, critical frequency, Effect of Earth‟s Magnetic Field, Virtual Height , Maximum Usable Frequency, Skip distance, Noise, precipitation, Static fading, Multi-Hop Propagation, Space wave propagation Range, Effect of Earths Curvature, Troposphere Propagation, Duct Propagation.	8	4

Reference Books:

1. Jordan E. C. and Balmain K. G., Electromagnetic Waves And Radiating Systems, Prentice Hall, Reprint, 2010
2. Hayt Jr. William H, Engineering Electromagnetics, McGraw Hill
3. Krauss J. D., Antennas, McGraw Hill
4. Parasd K .D., Antennas and wave propagation, Khanna Publications
5. Chatterjee Rajeswari, Antenna Theory and Practices, Wiley Eastern
6. R. Collin, Antenna and radio wave Propagation, McGraw Hill

e-Learning Source:

NPTEL :: Electrical engineering- NOC: Electromagnetic

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	**3**	**1**					**2**						2	1				

CO2	**3**	**1**					**2**						1	1				
CO3	**3**	**1**					**2**						2	1				
CO4	**3**	**1**					**2**						1	1				
CO5	**3**	**1**					**2**						1	1				

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC306	**Title of the Course**	Microelectronics Technology	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	Electronic Devices and Circuits	**Co-requisite**					
Course Objectives	• Introduction to different types of integrated circuits. To learn about the silicon wafer preparation techniques, cleaning of wafers, crystal orientation and different epitaxial process. • To understand different types of oxidation techniques, thickness measurement of oxide and different oxide furnaces. To understand the dopant diffusion processes its models and different diffusion furnaces. • To learn about different photolithography and mask making and pattern transfer process. • To learn about different ion implantation techniques, its equipment, range and dopant distribution profiles. Introduction of chemical vapor deposition (CVD) and CVD process in IC fabrication. • To study about different fabrication steps of IC such as bipolar IC, MOS IC, and BiCMOS IC technology. To know about fault modeling, and characterization technique.						

Course Outcomes	
CO1	Students will be able to identify basic structure of BJT, NMOS, CMOS, BiCMOS Devices. Students will know about Crystal Growth & Silicon wafer preparation, cleaning and crystal orientation and defects.
CO2	Students shall able to understand different types of oxidation techniques and different oxide furnaces. Students will able to compute the thickness of the oxide. Students will able to understand dielectrics and polysilicon film deposition. Students will able to understand identify different ion implantation equipment and its process.
CO3	Students will able to compute different vapor phase epitaxial process and redistribution of impurities during epitaxy. Develop an understanding about chemical vapor deposition (CVD) and CVD process in IC fabrication.
CO4	Students will able to compute range and dopant distribution profiles. Student shall be able to select the suitable photolithography. To make mask making learn about pattern transfer process.
CO5	Student shall be able to explain about fabrication steps of IC such as bipolar IC, MOS IC, and BiCMOS IC technology. To know about fault detection and characterization technique.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Digital System	Introduction to Integrated Circuit-Bipolar, MOS, BICMOS, basic circuits and structures, Silicon Wafer preparation and characterization-lapping, polishing, cleaning, resistivity measurement using 4 Point probe, crystal orientation, n-type, p-type, defects in crystal.	8	1
2	Thermal Oxidation	Dry, Wet and Steam oxidation, estimation of oxide layer thickness, furnace for oxidation system, plasma oxidation, dopant distribution at the interface.	8	2
3	Diffusion of Dopant	Diffusion equation, dopant profile for constant source and limited source, diffusion, sheet resistance, diffusion furnace and accessories for solid, liquid and gaseous sources, measurement of sheet resistance.	8	3
4	Ion Implantation	Ion implantation equipment, ion implantation techniques, range and distribution, dopant profile, annealing.	8	4
5	Epitaxy	Epitaxial reactor, Vapor Phase epitaxial processes for doped silicon, donor and acceptor atoms redistribution during epitaxy	8	5

Reference Books:

- SZE S M (SE) "VLSI Technology", Mc Graw Hill International.
- Gandhi S, "VLSI fabrication principles", Wiley Publication.
- Campbell S A, "The Science and Engineering of Microelectronics fabrication" Oxford University press.
- Geiger Randall L, Allen Phillip E, Stader Noel R, "VLSI Design Technique for Analog and Digital

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	1	1		1	2				3	2	1	1
CO2	3	1		3	2	1			2		1		3	2	1	
CO3	3	3		1	2	1			1			1	3	2	1	
CO4	3	1	2	3	2	1			1				2	1	1	1
CO5	3	3	2	2	1	1			1				2	1		1

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC307	**Title of the Course**	Semiconductor Fabrication Technology	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	Electronic Devices and Circuits (EC-201)	**Co-requisite**					
Course Objectives	• To learn about the silicon wafer preparation techniques, cleaning of wafers, crystal orientation and different oxidation process thickness measurement of oxide and different oxide furnaces. • To understand different types of epitaxial techniques. To understand the dopant diffusion processes its models and different diffusion furnaces. • To learn about different photolithography and mask making and pattern transfer process. • To learn about different ion implantation techniques, its equipment, range and dopant distribution profiles. Introduction of chemical vapor deposition (CVD) and CVD process in IC fabrication. • To study about different fabrication steps of IC such as bipolar IC, MOS IC, and BiCMOS IC technology. To study and explain about assembly & packaging of IC technology.						

Course Outcomes	
CO1	Students will be able to identify about Crystal Growth & Silicon wafer preparation, cleaning and crystal orientation and defects. Students shall able to understand different types of oxidation techniques and different oxide furnaces. Students will able to compute the thickness of the oxide.
CO2	Students will able to compute different vapor phase epitaxial process and redistribution of impurities during epitaxy. Students will able to understand dielectrics and polysilicon film deposition.
CO3	Student shall be able to select the suitable photolithography. To make mask making learn about pattern transfer process.
CO4	Students will able to understand identify different ion implantation equipment and its process. Students will able to compute range and dopant distribution profiles.
CO5	Student shall be able to explain about fabrication steps of IC such as bipolar IC, MOS IC, and Assembly & Packaging of IC technology.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction, Crystal Growth & Oxidation	• Introduction to Integrated Circuits, Moore's law, monolithic ICs, hybrid ICs. • Crystal Growth: MGS, EGS, Czochralski crystal Puller, Float Zone method, Silicon shaping, Wafer Preparation, cleaning, polishing, resistivity measurement, crystal orientation, defects in crystal. • Oxidation: Thermal Oxidation Kinetics, Oxidation Techniques, Oxide Properties, Oxidation induced defects.	8	1
2	Thin film Deposition Techniques	• Thin film deposition techniques: Epitaxy, Vapor Phase epitaxy (VPE), CVD, PECVD, MOCVD, PVD, ALD, Sputtering, MBE and epitaxial layer evaluations.	8	2
3	Lithography & Etching	• Lithography: Mask making, negative and positive photo-resist, Photolithography, E-beam lithography, X-ray Lithography, LIGA • Etching: Isotropic and an-isotropic etching, reactive plasma etching, plasma properties, Feature Size control and anisotropic etching, Plasma etching techniques and equipment.	8	3
4	Diffusion & Ion Implantation	• Diffusion: A Qualitative view of atomic diffusion in Solids, diffusion mechanisms, Fick's one-dimensional diffusion equation, constant source and limited source diffusion, Diffusion of Group 3 and 5 impurities in Silicon Impurity Sources, diffusion apparatus, Characterization of diffused layers. • Ion Implantation: Introduction, Range Theory, Implantation Equipment, Annealing.	8	4
5	Fabrication steps of IC & Assembly & Packaging	• Introduction to surface and bulk micro-machining, Isolation Techniques, Bipolar IC fabrication Process Sequence, N-MOS IC fabrication Process Sequence, C-MOS IC fabrication Process Sequence. • Assembly & Packaging: Package Types, design considerations, Package fabrication technologies, Future trends reference to MEMS packaging.	8	5
Reference Books:				

- Gandhi, VLSI fabrication principles, John Wiley
- S A Cambell, The science and engineering of Microelectronic Fabrication, Oxford University Press
- S M Sze, VLSI technology, McGraw Hill International Student Ed.
- Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, Third Edition, Three-Volume Set Hardcover, CRC Press.

e-Learning Source:

https://onlinecourses.nptel.ac.in/noc21_ee86/preview

https://youtu.be/366BVdmcUxk

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		1	1	1		1	2			2	3	2	1	1
CO2	3	1	1	1	2	1			2		1	2	3	2	1	1
CO3	3	3	1	1	2	1			1			1	3	2	2	1
CO4	3	1	2	2	2	1			1			2	2	1	2	1
CO5	3	3	2	2	1	1			1			2	2	1	2	1

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC 308	**Title of the Course**	Computer Organization & Architecture Lab	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V			**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	**Students may understand the basic principles about computer architecture, machine language, and low level programming. • Teach students enough assembly language to enhance their knowledge on today's most widely used microcomputer family**						

Course Outcomes	
CO1	To design and study 2 bit magnitude comparator and also verify multiplexer and de-multiplexer using IC 74153 & 74155
CO2	To design and study 1 bit memory cell and implement JK and SR Flip Flop using NAND gate and NOR gate and verify its truth table
CO3	To design and implement 2*2 bit unsigned multiplier also study the verification of Arithmetic logic unit.
CO4	To Design a MOD 10 asynchronous counter.
CO5	To perform hexadecimal addition and subtraction using 8086 microcontroller kit.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Magnitude Comparator	Design and study of 2 bit magnitude comparator	2	1
2	Memory cell	Design and study of 1 Bit memory cell.	2	1
3	Unsigned multiplier	Design and study of 2*2 bit unsigned multiplier circuit using 2 half adder and AND Gate.	2	2
4	S-R & J-K Flip Flop	Study of S-R & J-K Flip Flop using NAND gates and verification of their truth.	2	2
5	Multiplexer and de-multiplexer	Study and verify the truth table of multiplexer and de-multiplexer using 74153 & 74155.	2	3
6	S-R Flip- Flop	Design and implementation of S-R Flip- Flop using NOR gates and Verification of its truth table.	2	3
7	Arithmetic and Logic Unit	Study and verification of Arithmetic and Logic Unit.	2	4
8	Asynchronous counter	Design of MOD 10 Asynchronous counter.	2	4
9	Hexadecimal addition	Hexadecimal addition of two numbers using 8086 kit.	2	5
10	Hexadecimal subtraction	Hexadecimal subtraction of two numbers using 8086 kit.	2	5

e-Learning Source:

https://www.youtube.com/watch?v=Ol8D69VKX2k

https://www.youtube.com/watch?v=L9X7XXfHYdU

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	1	3	0	0	0	0	0	3	0	0	1	3	2	1			
CO2	3	2	3						3			1	3					
CO3	3	3	3	1	1				3				3	2	1			

CO4	3	3	2						3			1	3					
CO5	3	2	2	1	1				3			1	3	2	1			

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC309	**Title of the Course**	Integrated Circuit-Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**2**	**2**
Pre-Requisite	Mathematics, Basic Electronics Engineering	**Co-requisite**					
Course Objectives	1. To understand the concepts of Phase Locked Loop (PLL). 2. To learn the analysis of a single stage MOS amplifier and constant current source. 3. To understand the concepts of Operational Amplifier. 4. To understand the concept of Multivibrators. 5. To understand the basic concepts logic families and acquire knowledge of voltage regulator.						

Course Outcomes	
CO1	To understand the basic concepts of the circuit configuration for the design of linear integrated circuits and develops skill to solve engineering problems
CO2	Perform signal amplification through BJT and MOS and learn the emitter resistance in differential amplifier replaced by constant current source.
CO3	Student will be able to design mathematical operation using op-amp and OTA.
CO4	Student will be able to design analog multipliers circuit and perform multiplication and division operation and generate the square waveform using Multivibrators.
CO5	Student will be able to design the logic gates using TTL, ECL and IIL. Student will be able to design the power supply circuit.

Unit No.	Experiment No.	Content of Unit	Contact Hrs.	Mapped CO
1	**1**	Study and measurement of op amp parameter such as CMRR, offset volage, Bias current, Slew rate, frequency response and gain.	2	1
2	2	Design and study the op-amp as voltage to current and current to voltage converter.	2	1
3	3	Design and study the operation of a digital to analog converter using R-2R ladder.	2	2
4	4	Design and study the operation of analog to digital converter	2	2
5	5	Plot transfer characteristics if Schmitt Trigger and study the effect of dynamic comparison.	2	3
6	6	Design and study the op-amp as an Integrator and differentiator.	2	3
7	7	To study the Phase Locked Loop (PLL) using IC-565 and measure lock range and capture range.	2	3
8	8	Design and study the 2nd order low pass and high pass Butterworth Filter of 1Khz cutoff frequency, plot its frequency response002E	2	4
9	9	Design a voltage regulator using IC 723 for 10V output. Plot the output Voltage vs Input voltage characteristics.	2	4
10	10	Design astable and mono stable multivibrator using IC 555 Timer, for an Astable multivibrator determine the positive pulse width, negative pulse width and free running frequency.	2	5
11	11	Design frequency multiplier using Phase Locked Loop IC 565 and IC 7490	2	5

e-Learning Source:
https://www.vlab.co.in/broad-area-electronics-and-communications

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**	**3**			**2**			**3**			**1**	**1**	**2**		**4**
CO2	**3**	**2**	**3**						**3**			**1**	**1**		**3**	**4**
CO3	**3**	**3**	**2**	**2**	**1**				**3**			**1**	**1**	**2**		**4**
CO4	**3**	**3**				**1**			**3**			**1**	**1**	**2**		**4**
CO5	**3**	**2**		**1**	**1**			**3**	**3**			**1**	**1**	**2**		**4**

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC310	**Title of the Course**	Communication-1 Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**2**	**2**
Pre-Requisite	Mathematics, Basic Electrical Engineering	**Co-requisite**					
Course Objectives	1. To practice the basic theories of analog communication system. 2. To understand various Modulation and Demodulation techniques in time domain and frequencydomain, to Comprehend Pulse analog Modulation and Demodulation techniques 3. To impart hands on experience and train the students to SSB, DSB, DSB-SC signals and generateDSB-SC signal using balanced 4. To understand the radiation pattern of Dipole and Yagi- UdaAntenna						

Course Outcomes	
CO1	Develop the knowledge of Amplitude Modulation using a transistor (BJT) and determine thedepth of modulation.
CO2	Develop the knowledge of an envelop detector for demodulation of AM signal and observediagonal peak clipping effect.
CO3	Develop the knowledge of Frequency Modulation using voltage controlled oscillator.
CO4	Develop the knowledge of SSB, DSB, DSB-SC signals and generate DSB-SC signal using balanced modulator and generate the SSB signal and draw the output waveform using balanced modulator, Reconstruct the original signal from SSB signal
CO5	Develop the knowledge of Phase Lock Loop and detector of FM signal using PLL, radiationpattern of Dipole Antenna and Yagi- Uda Antenna

Unit No.	Experiment No.	Content of Unit	Contact Hrs.	Mapped CO
1	**1**	To study amplitude modulation using transistor (BJT) & determinedepth of modulation	2	1
2	2	To study DSB, DSB-SC signals and generate DSB-SC signal using balanced modulator.	2	1
3	3	Generate the SSB signal and draw the output waveform using balanced modulator. Reconstruct the original signalfrom SSB signal	2	3
4	4	To study envelop detector for demodulation of AM signal andobserve diagonal peak clipping effect.	2	2
5	5	Study of radiation pattern of Phase-Array Antenna.	2	1
6	6	Study of radiation pattern ofDipole Antenna.	2	5
7	7	Study of radiation pattern of Yagi-Uda Antenna	2	5

e-Learning Source:
https://www.vlab.co.in/broad-area-electronics-and-communications

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**	**3**						**3**			**1**	**1**	**2**		**4**
CO2	**3**	**2**	**3**						**3**			**1**	**1**		**3**	**4**
CO3	**3**	**3**	**2**	**2**	**1**				**3**			**1**	**1**	**2**		**4**
CO4	**3**	**3**							**3**			**1**	**1**	**2**		**4**
CO5	**3**	**2**		**1**	**1**				**3**			**1**	**1**	**2**		**4**

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC311	**Title of the Course**	System and Simulation Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**2**	**2**
Pre-Requisite	Mathematics, Basic Electrical Engineering	**Co-requisite**					
Course Objectives	❖ The main objective of system simulation lab is to provide the basic concepts of control system by using MATLAB and Scilab. ❖ To study and understand by experiments the various types of controllers. ❖ To study and analyze the transient response of series RLC circuit and lag network for compensation of the circuit. ❖ To study the transfer function of the control system by using MATLAB. ❖ To understand the concepts of various ladder logic programming for different applications.						

Course Outcomes	
CO1	Student shall be able to identify the open loop and closed loop system.
CO2	Student shall be able to understand the response of first and second order system through MATLAB.
CO3	For a given system the student shall be to understand the concept and responses of different control system.
CO4	Student shall be able to understand the response of controllers.
CO5	For a given system the student shall be to understand the stability by root locus through MATLAB and Scilab.

Unit No.	Experiment No.	Content of Unit	Contact Hrs.	Mapped CO
1	**1**	To study the performance characteristics of a dc motor speed control system (a) open loop (b) closed loop.	2	1
2	2	To study P, PI, and PID temperature controller for an oven and compare their performance.	2	2
3	3	To determine the transient response of series RLC circuit and also compare theoretical and practical results	2	3
4	4	To study the phase lag network and also plot the graph.	2	4
5	5	To simulate a DC motor (Armature control) system and draw the characteristics of the angular velocity using MATLAB.	2	1
	6	Plot the impulse, step and ramp response of a given transfer function using MATLAB and determine peak overshoot and peak time.	2	3
	7	To analyze the stability of given transfer function using Bode/Root-locus/Nyquist plot and find the gain margin and phase margin using MATLAB.	2	3
	8	To study the time response of a variety of simulated linear system and to correlate the studies with theoretical results: (a). Error detector cum gain. (b). Integrator. (c). Time constant.	2	5
	9	Draw Ladder logic to transfer liquid one container to another container with given conditions: (a). If temperature is proper and tank is not empty the pump remains off. (b). If temperature is not proper but tank is empty then pump remains off. (c). If both are proper then pump on for 20 sec. otherwise pump remains off.		

	10	Draw a ladder logic container for a pump which start by a push button to fill the tank with fluid. When tank 1(T1) IS FUII, the PLC should automatically start filling the tank 2 (T2) by closing valve V1and opening free valve V2and when tank 2 (T2) is full then pump will be disconnected automatically and sign lamp L is turned on to show both tank are full.		

Reference Books:

1. B.C Kuo, Automatic Control System, PHI
2. Katsuhiko Ogata, Modern Control Engineering, PHI
3. I.J.Nagrath & M.Gopal, Control System Engineering, New Age International Publisher
4. S.K. Bhattacharya, Control System Engineering, Pearson Education.
5. S. Hasan Saeed, Automatic Control System, Kataria and sons, New Delhi

e-Learning Source:

https://www.vlab.co.in/broad-area-electronics-and-communications

http://vlabs.iitb.ac.in/vlab/

https://vlab.amrita.edu/

http://ial-coep.vlabs.ac.in/

http://plc-coep.vlabs.ac.in/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	2		2	2	1	1		3	3	3	1
CO2	3	3	3	3	2	2		2	2	1	1		3	3	3	1
CO3	3	3	3	3	2	2		2	2		1		3	3	2	1
CO4	3	3	3	3	2	2		2	2	1	1		3	2	3	
CO5	3	3	3	3	2	2		2	2	1	1		3	3	3	1

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

Name & Sign of Program Coordinator	**Sign & Seal of HoD**