

EE 502	Digital IC Design	3-0-0	6
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### **Course Contents:**

Basic Electrical Properties of MOS circuits: MOS transistor operation in linear and saturated regions, MOS transistor threshold voltage, MOS switch and inverter, latch-up in CMOS inverter; sheet resistance and area capacitances of layers, wiring capacitances; CMOS inverter properties - robustness, dynamic performance, regenerative property, inverter delay times, switching power dissipation, MOSFET scaling - constant-voltage and constant-field scaling; dynamic CMOS design: steady-state behavior of dynamic gate circuits, noise considerations in dynamic design, charge sharing, cascading dynamic gates, domino logic, np-CMOS logic, problems in single- phase clocking, two-phase non-overlapping clocking scheme; subsystem design: design of arithmetic building blocks like adders – static, dynamic, Manchester carry-chain, look-ahead, linear and square-root carry-select, carry bypass and pipelined adders and multipliers - serial-parallel, Braun, Baugh-Wooley and systolic array multipliers, barrel and logarithmic shifters, area-time tradeoff, power consumption issues; designing semiconductor memory and array structures: memory core and memory peripheral circuitry.

### **Texts / References:**

1. J.M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits- A Design Perspective, 2nd ed., PHI, 2003
2. N.H.E. Weste and K. Eshraghian, Principles of CMOS VLSI Design - a System Perspective, 2nd ed., Pearson Education Asia, 2002
3. S.M. Kang and Y. Leblevici, CMOS Digital Integrated Circuits Analysis and Design, 3rd ed., McGraw Hill, 2003
4. J. P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons (Asia) Pte Ltd, 2002
5. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, IEEE Press, 1997.

EE 511	Semiconductor Device Modeling	3-0-0	6
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### Course Contents:

p-n Junctions: equilibrium conditions, forward and reverse-biased junctions, reverse-bias breakdown, transient and a-c conditions, recombination and generation in the transition, semiconductor heterojunctions, Metal-semiconductor junctions: Schottky barriers, rectifying and Ohmic contacts, Bipolar junction transistors: minority carrier distribution and terminal currents, generalized biasing, switching, secondary effects, frequency limitations of transistors, heterojunction bipolar transistors, Field-Effect Transistors: JFET-current-voltage characteristics, effects in real devices, high-frequency and high-speed issues, Metal Insulator Semiconductor FET, MOSFET-basic operation and fabrication; ideal MOS capacitor; effects of real surfaces; threshold voltages; output and transfer characteristics of MOSFET, short channel and Narrow width effects, MOSFET scaling, Optoelectronics Devices: Light emitting diodes, Lasers, Photoconductors, Junction Photodiodes, Avalanche Photodiodes, Solar Cells, SPICE Models for Semiconductor Devices: MOSFET Level 1, Level 2 and level 3 model, Model parameters; SPICE models of p-n diode and BJT.

### Texts / References:

1. B. G. Streetman and S. Banerjee, *Solid State Electronic Devices*, 6<sup>th</sup> Edition, PHI Private Limited, 2011.
2. P. Bhattacharya, *Semiconductor Optoelectronics Devices*, 2nd Edition, PHI, 2009.
3. G. Massobrio and P. Antognetti, *Semiconductor Device Modeling with SPICE*, 2nd Edition, TMH, 2010.
4. C. C. Hu, *Modern Semiconductor Devices for Integrated Circuits*, Pearson Education, 2010.
5. R. S. Muller and T. I. Kamins, *Device Electronics for Integrated Circuits*, 3rd Edition, Wiley India, 2009.
6. S. M. Sze and K. K. Ng, *Physics of Semiconductor Devices*, 3rd Edition, Wiley India, 2010.
7. Y. Tsididis, *Operation and Modeling of the MOS transistor*, 2nd Edition, TMH, 1999.
8. S. A. Neamen and D. Biswas, *Semiconductor Physics and Devices*, 4th Edition, TMH, 2012.

EE 515	Semiconductor IC Technology	3-0-0	6
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**Course Contents:**

Historical perspective, processing overview, crystal growth, wafer fabrication and basic properties of Silicon Wafers, Clean Rooms, Wafer Cleaning, Epitaxy, Thermal Oxidation of Silicon, Lithography, Wet and Dry Etching, Thin film deposition, Diffusion, Ion Implantation, Metallization, Process Integration: Passive components, Bipolar Technology, MOSFET Technology, MESFET Technology, MEMS Technology, IC Manufacturing: Electrical Testing, Packaging, Yield, Future trends and Challenges: Challenges for integration, system on chip.

**Texts / References:**

1. G. S. May and S. M. Sze, *Fundamentals of Semiconductor Fabrication*, Wiley India, 2004.
2. J. D. Plummer, M. D. Deal and P. B. Griffin, *Silicon VLSI Technology, Fundamentals, Practice and Modeling*, Pearson education, 2000.
3. S. M. Sze, *VLSI Technology*, 2nd Edn., TMH, 2004.
4. S. M. Sze, *Semiconductor Devices: Physics and Technology*, 2nd Edn., Wiley India, 2011.
5. W. R. Runyan and K. E. Bean, *Semiconductor Integrated Circuit Processing Technology*, Addison Wesley Publishing Company, 1990.
6. S. A. Campbell, *The Science and Engineering of Microelectronic Fabrication*, Oxford University Press, 1996.
7. M. J. Madou, *Fundamentals of Microfabrication*, 2nd Edition, CRC Press, 2011.

EE 512	VLSI Lab I	0-0-3	3
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**Course Contents:**

Experiments are based on the following topics: Model Parameter extraction for a diode and MOSFET; NMOS and PMOS characteristics; Inverter characteristics; layout of resistors, capacitors, transistors and inverter; 1-bit Shift Register; digital logic cells; adders; multipliers; Ring Oscillator.

**Texts / References:**

1. M. H. Rashid, *Introduction to PSpice Using OrCAD for Circuits and Electronics*, 3rd Edition, Prentice-Hall India, 2006.
2. Charles H Roth Jr., *Digital Systems Design Using VHDL*, 8th Indian reprint, Thomson Learning Inc., 2006.
3. J. M. Rabaey, A. Chandrakasan and B. Nikolic, *Digital Integrated Circuits- A Design Perspective*, 2nd Edition, PHI, 2003.
4. N. H. E. Weste and K. Eshraghian, *Principles of CMOS VLSI Design: A Systems Perspective*, Pearson Education, 2004.
5. Mentor Graphics CAD software manuals.

EE 503	Analog IC Design	3-0-0	6
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**Course Contents:**

Introduction to analog VLSI and mixed signal issues in CMOS technologies; Basic MOS models, SPICE Models and frequency dependent parameters; Basic MNOS/CMOS gain stage, cascade and cascode circuits; Frequency response, stability and noise issues in amplifiers; CMOS analog blocks: Current Sources and Voltage references; Differential amplifier and OPAMP design; Frequency Synthesizers and Phased lock-loops; Non-linear analog blocks: comparators, charge-pump circuits and multipliers; Basics of data converters; Analog Testing and Layout issues; Low Voltage and Low Power Circuits; Introduction to RF Electronics.

**Texts / References:**

1. B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill 2001
2. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University Press, 1997
3. B. Razavi, RF Microelectronics, Prentice-Hall, 1998.
4. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, IEEE Press, 1997.
5. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001.
6. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002.

EE 561	VLSI System Design	3-0-0	6
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**Course Contents:**

Basics of system hardware design: Hierarchical design using top-down and bottom-up methodology, System partitioning techniques, interfacing between system components, Handling multiple clock domains, Synchronous and asynchronous design styles; Design of finite state machines: state assignment strategies; The Processor: Data path and Control, Enhancing performance with Pipelining, exploiting of Memory hierarchy.

**Texts / References:**

1. G. De. Micheli, Synthesis and Optimisation of Digital Circuits, Tata McGraw-Hill, 2004.
2. D. A. Patterson and J. L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 2nd Edition, Morgan Kaufmann Publishers, Inc, 1998.
3. J. Rabaey, Digital Integrated Circuits, A Design Perspective, 2nd Edition, Pearson Education, 2003.
4. H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Eight Indian Reprint, Pearson Education, 2002.
5. C. Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley, 1979.

EE 663	VLSI DSP	3-0-0	6
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### **Course Contents:**

Introduction to DSP systems: Representation of DSP algorithms; Iteration Bound: Definition, Examples, Algorithms for computing Iteration bound; Pipelining and Parallel Processing: Definitions, Pipelining and parallel processing of FIR filters, Pipelining and parallel processing for low power; Retiming: Definitions and Properties, Solving system of Inequalities, Retiming techniques; Unfolding: Definition, An algorithm for unfolding, Applications of unfolding; Folding: Definition, Folding transformations, Register minimization techniques, Register minimization in folded architectures; Systolic Architecture Design: Introduction, Systolic array design methodology, FIR systolic arrays, Selection of scheduling vector, Matrix-Matrix multiplication and 2D systolic array design; CORDIC based Implementations: Architecture, Implementation of FIR filter and FFT algorithm; Bit-Level arithmetic architectures: Parallel multipliers, Bit-serial multipliers, Bit-Serial FIR filter design and Implementation; Redundant arithmetic: Redundant number representation, Carry-free radix-2 addition and subtraction, radix-2 hybrid redundant multiplication architectures; Low-power design: Theoretical background, Scaling versus power consumption, Power analysis, Power reduction techniques, Power estimation approaches.

### **Texts / References:**

1. U. Meyer-Baese, DSP with FPGA, Springer, 2004.
2. K. K. Parhi, VLSI DSP Systems, Wiley, 2003.
3. R.G. Lyons, Understanding Digital Signal Processing, Pearson Education, 2004.

EE 513	VLSI Lab II	0-0-4	4
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**Course Contents:**

Experiments are based on the following topics: NMOS and PMOS characteristics; Common source amplifiers; Layout of resistors, capacitors, transistors; differential amplifier; cascode amplifier; current mirror; push pull CS amplifier; negative feedback amplifier; multistage amplifiers; operational amplifiers and comparators.

**Texts / References:**

1. M. H. Rashid, *Introduction to PSpice Using OrCAD for Circuits and Electronics*, 3rd Edition, Prentice-Hall India, 2006.
2. B. Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw Hill, 2001.
3. B. Razavi, *RF Microelectronics*, Prentice-Hall, 1998.
4. P. E. Allen and D. R. Holberg, *CMOS Analog Circuit Design*, 2nd Edition, Oxford University Press, 1997.
5. D. A. Johns and K. Martin, *Analog Integrated Circuit Design*, Wiley Student Edition, 2002.
6. P. R. Gray and R. G. Meyer, *Analysis and Design of Analog Integrated Circuits*, 4th Edition, Wiley Student Edition, 2001.
7. Mentor Graphics CAD software manuals.

EE 514	VLSI Lab III	0-0-4	4
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**Course Contents:**

Experiments/Projects are based on the following topics: RF front-end: LNA, Mixer, VCO, Frequency Synthesizer, Power Amplifiers and Filters; ADCs, DACs and Digital Compensation techniques; base band designs: Filters, FFT, DCT, Channel coders and Decoders - Viterbi, Reed Solomon, Turbo Codes; Modulation, Synchronization and Timing Recovery Circuits; Image/Video compression techniques.

**Texts / References:**

1. B. Razavi, *RF Microelectronics*, Prentice-Hall, 1998.
2. P. E. Allen and D. R. Holberg, *CMOS Analog Circuit Design*, 2nd Edition, Oxford University Press, 1997.
3. B. Leung, *VLSI for Wireless Communication*, Person Education, 2002.
4. R. J. Plassche, *CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters*, John Wiley & Sons, Inc., 2004.
5. F. Horlin and A. Bourdoux, *Digital Compensation for Analog Front-Ends: A New Approach to Wireless Transceiver Design*, John Wiley & Sons Inc., 2008.
6. K. K. Parhi, *VLSI Digital Signal Processing: Systems, Design and Implementation*, Wiley Interscience, 2007.
7. E. C. Ifeachor and B. W. Jervis, *Digital Signal Processing – A Practical Approach*, 2nd Edition, Pearson Education, 2002.
8. B. Sklar, *Digital Communications*, Pearson Education, 2001
9. Mentor Graphics CAD software manuals.