Revised syllabus for M.Sc. (Electronics)

Semester III – IV (With effect from 2016-2017)

Structure of Courses

Semester	Course	Title of the course	Marks		Hours per week
			Int.	Ext.	
III	EL-301	Digital Signal Processing and Applications	40	60	04
	EL-302	Semiconductor Devices Processing and Fabrication	40	60	04
	El-303	Embedded System Design and Applications	40	60	04
	EL-304	Practical's Lab III	40	60	24
	EL-305	Project I	40	60	24
	EL-306	Seminar – I (Audit course)	40		02
IV	EL-401(A)	Modeling and Simulation Techniques	40	60	04
	EL-401(B)	Micro-electromechanical Systems and Applications	40	60	04
	EL-402	CMOS Design and Applications	40	60	04
	EL-403	Digital Image Processing and Applications	40	60	04
	EL-404	Practical's Lab IV	40	60	24
	EL-405	Project II	40	60	24
	EL-406	Seminar – II (Audit course)	40		02

EL-301 Digital Signal Processing and Applications

Unit I: Basics of Digital Signal Processing

Analog Vs. Digital Signal Processing, Block diagram of digital signal processor, Sampling Theorem, Sampling, Quantization, Aliasing. **[5]**

Unit II: Signals and Systems

Basic signals, representation of signals in various ways, types of signals, systems: classification of systems, properties of systems, LSI system, delta function, impulse response, linear convolution, properties of convolution, correlation, its type and applications. **[12]**

Unit III: Mathematical Transforms

Z-transform, Definition, region of convergence, properties of Z-transform, inverse Z-transform: various methods, DTFT, properties, DFT, properties, circular convolution, graphical method and matrix method, FFT. **[17]**

Unit IV: Filters

Types of filters, Infinite impulse response filters, Finite impulse response filters, various window functions, Implementation of these filters, Analog filters. **[12]**

Unit V: DSP Applications

Audio compression and decompression, audio equalization, audio noise cancellation, audio echo cancellation, video compression, video stabilization, image compression, face finding, image resizing, data modulation and demodulation, speech synthesis, mobile telephone, set top box and ECG monitoring. **[5]**

References:

1. **Digital Signal Processors**- Kuo and Gan, Pearson Education
2. **Digital Signal Processing**: D. J. DeFatta, J. G. Lucas and W. S. Hodgkiss, J Wile and sons, Singapore.
3. **Digital Signal Processing**:Principle, Algorithms and Applications, John G. Proakis and D.G. Manolakis, Prentice Hall.
4. **Theory and Application of Digital Signal Processing**: L. R. Rabiner and B. Gold, Prentice Hall.
5. **Introduction to Digital Signal Processing**: J.R. Johnson, Prentice Hall
6. **Industrial Control Electronics** – Applications and Design, Michael Jacob Prentice Hall.

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EL-302 Semiconductor Devices Processing and Fabrication

Unit I: Crystal Structures, growth and wafer preparation
Crystal structures of semiconducting materials, CZ and Bridgeman techniques, Zone refining, Ingot shaping, Polishing, Cutting, Wagering, Scribe lines, Cleavage. **[8]**

Unit II: Fabrication and Deposition Techniques
Diffusion: Nature of diffusion, the diffusion concentration, Field aided motion, Impurity behavior in silicon, substitutional diffusers, ion implantation, Epitaxy: Vapor phase epitaxy, reaction at the substrate, Elements of nucleation and growth, Doping and auto-doping, Formation of GaAs (reaction involved) liquid phase epitaxy, Tilt type growth furnace, Slider boat arrangement, Reactors for Si and GaAs growth, Molecular beam epitaxy (MBE), Silicon, Insulators, sapphire and amorphous substrates, Evaluation of Epi-layers. **[10]**

Unit III: Lithography
Positive and negative resists, development, photo mask and its preparation, scaling, patterning, reticle masks, master mask, production mask, alignment mask. Optical lithography, contact printing, projection printing, proximity printing. Proximity effect and its corrections, vary figures, variable exposure, Electron beam lithography (EBL) step and repeat method, electro-beam mask fabricator (EBMF), (Telecantric effect) laser beam, ion beam lithography, X-ray lithography, future trends. **[8]**

Unit IV: Oxidation
Thermal oxidation of silicon, kinetics of oxide growth, network formers, network breakers bridging oxygen, Thermal Oxidation: Dry, Wet, Rapid thermal, pyrogenic oxidation, Halogenic low pressure oxidations, Techniques of oxidation (chlorine enhanced oxidation), Oxidation furnaces, high and low pressure oxidations. Techniques and difficulties in growing good quality thin oxide layers, Oxidation induced staking faults, Plasma Oxidation: Deal grove model assumptions, segregation coefficient, impurity redistribution during oxidation, failure of Deal grove model in initial stages, Model micropores field enhanced oxidation, Properties of thermal, anodic and plasma oxides evaluation of oxide layers. **[13]**

Unit V: Characterization Techniques
Physical Characterizations: Refractive Index measurement, XRD, SEM, TEM, Elliposometry, Taley step, Electrical Characterization: I-V, C-V measurement, impurity profile measurement, Bevelling grove methods, Hall probe technique, resistivity measurement, Four probe technique, Hall

Measurement, Sheet resistance, Mobility and carrier concentration and impurity profile measurements, Vander Pau method, breakdown strength measurement, Chemical Characterizations: Spectroscopic Techniques U-V, RHEED, ESCA. **[11]**

References:
1. **VLSI Fabrication principles**, S. K. Gandhi, John Willey and Sons.
2. **VLSI technology**, S, M. Sze, Mc Graw Hill Int. Book Co.
3. **Integrated Circuit Engineering**, B. Glasser and S. Sharpe
4. **Semiconductor Integrated Circuit fabrication techniques :** P. E. Gise and R. Blanchard

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EL-303 Embedded Systems

Unit I: Introduction

Embedded system, components of embedded system, processor, memory, microcontroller, DSP, Application specific system processor, power supply management, clock oscillator, reset circuit, Input/output ports, buses and interfaces, DAC and ADC, LCD and LED displays, keypad/keyboard, Types of interrupts, interrupt priorities. **[10]**

Unit II: Embedded on chip Hardware

Memory, memory interface unit, programming the memory, embedded system input/output devices, timers, 8253, different operating modes, parallel ports, memory mapped Input/output, serial ports, UART. **[7]**

Unit III: Embedded Communication

Parallel data communication, GPIB and HPIB standards, serial data communication, Asynchronous communication and standards, PC-PC communication, modem, computer-modem interfacing, network communication, I^2C bus standard, wireless communication. **[7]**

Unit IV: Embedded System Software and testing of systems

Real time systems, model of real time systems, Characteristics of real time systems, Features of real time operating system, Unix as a RTOS, windows as a RTOS, Task scheduling in embedded systems: task scheduler, first in first out, shortest job first, round robin, priority based scheduling, Programming languages: assembly languages, high level languages, Verification vs. testing, faults in embedded system, hardware fault models, software-hardware co-validation fault models, embedded software testing.

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Unit V: Applications of Embedded Systems

Mobile phones, home appliances, microwave oven, washing machine, laser printer, Automated Teller Machines, Bluetooth communication, automated car assembly plant, chemical plant control. **[6]**

References:
1. **Fundamentals of Embedded Software**- Daniel W Lewis, Pearson Education
2. **An embedded software primer**, David E Simon, Pearson education
3. **Embedded Micro-computer System: Real Time Interfacing**, J.W. Valvano.

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EL-304 Practical- Lab III

Part-A

1. Implement moving average filter using MATLAB.
2. Write MATLAB program for the magnitude and phase response of the signal.
3. Study of Auto-correlation using MATLAB.
4. Study of Liner and Circular convolution techniques using MATLAB.
5. Study of low pass filter using DSP kit.

Part-B

6. Study of wafer handling and cleaning.
7. Growth of Silicon dioxide layer for the microelectronics applications.
8. Photolithography using photo resist.
9. Studies on dry and wet etching processes for semiconductor thin films.
10. Studies on optical characterization techniques ellipsometry.
11. Studies on optical characterization techniques FTIR.
12. I-V characteristics of BJT / MOSFET devices.

Part-C

13. Write program for Arithmetic operations using ARM processor.
14. Write code conversion program using ARM processor.
15. Interface Relay to ARM processor.
16. Interface DC motor to ARM processor.
17. Interface DAC to ARM processor.

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EL-401(A) Modeling and Simulation Techniques

Unit I: Introduction
Models and their types, need of modeling, physical models, analog models, probabilistic and deterministic models, static and dynamic models, Common types of mathematical models used for engineering systems, Model determination from input- output observation, Basic principle of simulation, Analog and digital simulation techniques, material level simulation, physical level simulation, logic level simulation and behavioral level simulation, mixed level simulation. **[10]**

Unit II: Semiconductor device simulation
Materials used for light emitting devices, hetero-structure, double-heterostructure, quantum-well, different recombination mechanisms, Maxwell's equations, Derivation of Poisson's and Laplace's equation, continuity equation for electrons and holes, current density expressions, simplification of these equations, drift-diffusion approximation, limitations of drift-diffusions, wave equations for TE and TM modes, modeling of semiconductor laser diode, selfconsistent analysis. **[17]**

Unit III: Computational Techniques for device simulation
Finite difference methods, first order and second order derivatives obtained from Taylor's series, comparison with finite element method, solution of poison's equation, solution of steady state continuity equation for electrons and holes, discretization of these equations, analysis of simulation results, random number generation and testing, Monte Carlo integration, basic concepts. **[10]**

Unit IV: Modeling of diodes and Transistors
P-n junction: contact potential, depletion width and current models, BJT: small signal and large signal models, Eber-Moll's model, JFET: model of pinch-off voltage and drain current of MOSFET: small signal and large signal models **[7]**

Unit V: Nano-scale Electronics device modeling
Schrödinger's equation, quantum transport, Nanoscale devices: quantum well, quantum wire and quantum dots, transfer matrix formation for multiple quantum wells. **[6]**

References:
1. **System Simulation**, G. Gordon, Prentice Hall
2. **Modeling and Simulation**, R. Leigh, Peter Peregrims Ltd.
3. **Simulation Modelling and Analysis**, M. Law, W. D. Kelton, McGraw Hill.
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EL-401(B) Micro-electromechanical Systems and Applications

Unit I: Introduction to Micro-electromechanical systems and MEMS design
What is MEMS? MEMS technology, brief history of MEMS, MEMS design tools, bulk-micromachining based MEMS design, surface-micromachining based MEMS design. **[10]**

Unit II: Material issues for microsystems
Failure mechanisms of materials used in Microsystems, methods for measuring mechanical properties of materials used in Microsystems, structure materials for Microsystems, materials for microtribological application. **[11]**

Unit III: MEMS processing and fabrication techniques and technology
Silicon based micromachining, surface micromachining technology: standard surface micromachining technology and multilayer polysilicon, metallization, isolation, monolithic integrated surface micromachining technology, 3D surface machining, other materials, bulk micromachining. **[12]**

Unit IV: Micro-electromechanical sensors
Physical sensors, chemical sensors, biological sensors, resonant pressure sensors, resonant accelerometers, resonant gas flow sensors, silicon based electrostatic field sensors, MEMS based microgas sensors: micro-hotplate gas sensor, micro-gas sensor array, nanofiber based gas sensing materials. **[14]**

Unit V: MEMS Packaging
MEMS packaging fundamentals, contemporary MEMS packaging approaches, bonding processes for MEMS packaging: fusion bonding, anodic bonding, epoxy bonding, eutectic bonding, solder bonding, localized heating and bonding, Vacuum packaging: integrated micromachining, post packaging, hybrid approach.

References:
1) **Microsystems and nanotechnology**, Zhaoying Zhou, Zhonglin Wang, Liwei Lin, Springer.
2) **MEMS AND Microsystems: Design And Manufacture 1st Edition**, Tai-Ran Hsu, Mcgraw Hill Education.
3) **Mems and Nems**, Lyshevski, CRC press.
4) **Advanced Mechatronics and MEMS Devices 1st Edition**, Dan Zhang, Springer New York.
5) **MEMS**, MAHALIK N P, Mcgraw Hill Education.

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EL-402 CMOS Design and Applications

Unit I: Basic Electrical Properties of MOS Transistor

Threshold Voltage V_{th}, Transconductance gm for MOS, MOS Transistor Circuit Model, CMOS and Bi-CMOS Inverters, Inverter Principle, Depletion and Enhancement Load Inverters, The Basic CMOS Inverter, Transfer Characteristics, MOS Transistor Figure of Merit, Latch-up in CMOS Circuits, Noise Margins, Dynamic Behavior, Power Dissipation, Determination of pull-up to pull-down Ratio for nMOS Inverter Driven by Another nMOS Inverter.   **[15]**

UNIT II: MOS Circuit Layout

MOS Layers, Stick Diagrams: nMOS Design Style, CMOS Design Style. Scalable Design Rules: Lambda Based Design Rules, Contact Cuts, Double Metal MOS Process Rules, CMOS Lambda Based Design Rules. MOS Device Layout: Transistor Layout, Inverter Layout, CMOS Digital Circuit Layouts and Simulation.   **[10]**

UNIT III: Sub System Design, Layouts and Process

Switch Logic: Pass Transistor and Transmission gate, Gate Logic: The Inverter, NAND Gate, NOR Gate, Others form of CMOS Logic. Structured Design: A Parity Generator, Multiplexer, 4 Bit Shifter, 4 Bit Adder.   **[12]**

UNIT IV: Basic Circuit Concepts

Sheet Resistance, Sheet Resistance for MOS Transistor and Inverters, Area Capacitance of Layers, Standard Unit of Capacitance, Area Capacitance Calculation, The Delay Unit, Inverter Delay, Propagation Delay.   **[6]**

UNIT V: Sequential Circuits

Static Latches, Flip Flops and Registers, Dynamic Latches and Registers, CMOS Schmitt Trigger, Monostable Sequential Circuits, Astable Circuits. Memory Design: RAM Cells   **[7]**

References:
1. **Essentials of VLSI Circuits and Systems**, K. Eshraghian
2. **Digital Integrated Circuits**, Rabey, Pearson Education
3. **CMOS Digital IC Circuit Analysis and Design**, Kang and Leblebigi

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EL-403 Digital Image Processing and Applications

Unit I: Introduction
Components of an; Image Processing system and Applications, Human Eye and Image Formation Sampling and Quantization, Basic Relationship among pixels neighbor, connectivity, regions, boundaries, distance measures. **[10]**

Unit II: Image processing operations
Image Enhancement: Spatial Domain-Gray Level transformations, Histogram, Arithmetic/Logical Operations, Spatial filtering, Smoothing and Sharpening Spatial Filters, Frequency domain filtering and smoothening operation. **[13]**

Unit III: Image segmentation and Thresholding
Image Segmentation: Discontinuities, Edge Linking and boundary detection, Thresholding, Region Based Segmentation, Watersheds; Introduction to morphological operations; binary morphology - erosion, dilation, opening and closing operations, applications; basic gray-scale morphology operations; Feature extraction; Classification; Object recognition. **[12]**

Unit IV: Image Restoration and compression:
Inverse filtering, Wiener filtering; Wavelets- Discrete and Continuous Wavelet Transform, Wavelet Transform in 2-D, Redundancies- Coding, Interpixel, Psycho visual; Fidelity, Source and Channel Encoding, Image Compression Standards-JPEG, JPEG 2000, MPEG; Video compression. **[8]**

Unit V: Color image processing:
Color fundamentals, color models, Pseudocolor image processing, basics of full color image processing, color transformation, Color image filtering: smoothening and sharpening, color segmentation: segmentation in HSI color space, segmentation in RGB color space, color edge detection. **[7]**

References:
1. **Digital Image Processing,** R. C. Gonzalez and R. E. Woods, Pearson Education
2. **Digital Image Processing using MATLAB**, R. C. Gonzalez , R. E. Woods and S. L. Eddins, Pearson Education
3. **Fundamentals of Digital Image processing,** A. K. Jain, Pearson Education

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EL-404 Practical- Lab IV

Part-A (Using MATLAB)

1. Finite difference discretization and solution of Poisson's equation.
2. Analysis of simple p-n junction diode using static model.
3. Random number generation and Monte Carlo integration.
4. Simulation of Eber-Moll model for the BJT.
5. Simulation of large signal model for MOSFET.
6. Solution of wave equation for the field intensity distribution.

OR

Part-A

1. Study the principle and working of electromechanical actuators.
2. Study the principle and working of electromechanical sensors.
3. Study the principle and working of bimetal actuators.
4. Study the principle and working of hydraulic actuators.
5. Study the principle and working of Pneumatic actuators.

Part-B

7. Sketch layout and study CMOS inverter using tools.
8. Draw transistor schematic for two/three input logic gates and sketch layouts using tools.
9. Draw transistor schematic for parity generator and sketch layout using tools.
10. Draw sticks diagram and layout for different flip flops.
11. Sketch layout and study multiplexer using tools.
12. Sketch layout and study S-RAM using tools.

Part-C (Using MATLAB)

13. Read an image and perform edge modification operations using MATLAB.
14. Perform erosion, dilation, opening and closing operation over image.
15. Perform skeletonization operation over finger print.
16. Color image filtering using MATLAB
17. Perform histogram operation on images having different contrast levels.
18. Study the basic grey level transformations.
19. Perform image compression using MATLAB.

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