| No | Type | Subject/ Module |
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| 1 | **Theory** | **Semiconductor Material and Devices**<br>• IC Product Design Cycle<br>• Design Approaches<br>• Design Economics<br>• IC Design Methodology<br>• Design Tools<br>• Process Design Kits (PDK)<br>• Full Custom Design<br>• Design Flow<br>• Design Guidelines<br>• ASIC Design<br>• MPW Design Prototyping<br>• Models for Circuit Simulation<br>• Capacitor Model<br>• Resistor Model<br>• MOSFET<br>• BJT<br>• Model & Statistical Process Variation |
| 2 | **Theory** | **Library (Design)**<br>• IC Design Infrastructure<br>• Design Flow Overview<br>• Full Custom Design Flow<br>• Digital Design Flow<br>• EDA Tools<br>• Design Libraries<br>• Device Modeling<br>• Methodology & Variation<br>• Measurement Setup |
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| | **Theory** | **Cleanroom Protocol and Safety**<br>• Cleanroom environment requirement<br>• Cleanroom cleanliness<br>• Gowning and degowning procedure<br>• Safety legal and other requirements |

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| 3 | | • Chemical safety principles and concepts<br>• Chemical hazards classification and information<br>• Standard operating procedures<br>• Emergency response |
| | **Practical** | • Perform the gowning and de-gowning procedure<br>• Practice cleanroom protocol<br>• Understand emergency evacuation route |
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| 4 | **Theory** | **Process Integration**<br>• Overview of Wafer Fabrication<br>• Process Flow – CMOS process<br>• Device Physics<br>  ○ Transistor – NMOS and PMOS<br>  ○ Diode, Resistor, Capacitor<br>• Statistical Process Control<br>  • Statistic :sample/population, normal distribution, average, median, standard deviation, variance, mean, range<br>  • Variation in processes: Common cause and special cause<br>  • Control charts<br>  • Control limit calculation<br>  • Control Chart Pattern<br>• Design of Experiment |
| | **Practical** | • Runcard Setup based on Process Flow<br>• Runcard Setup Review<br>• Cleanroom Activities – Planning and running of the engineering lot<br>• Common equipment operation – WS201, WB202, WB201, SB201, AS201, manual handling<br>• Common metrology tool operation- CDSEM, AIT, MS201, FT201, PP201<br>• Cleanroom activities – Running of the engineering lot – Running of engineering and GOI lots<br>• Cleanroom activities – inspection on pattern, after etch and etc for any abnormalities<br>• Introduction of test structures and design rule overview(L-edit) |

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| | | • Characteristic of device – transistors, diode, resistor, capacitor (Test) |
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| 5 | **Theory** | **Fabrication Process Modules**<br><br>**Photolithography Process**<br><br>• Concept of Light, Light Source<br>• Resolution and Depth of Focus<br>• Types of printing<br>• Resist Chemistry<br>Process Flow<br>• Prime, Apply (Coating), Soft Bake<br>• Imaging & alignment<br>• Post Exposure Bake<br>• Develop, Deep UV and Overlay<br>• Common error and trouble shooting<br>• Inspection Microscope – pattern, defect, particle<br>• CD Measurement<br>• Swing curve |
| | **Practical** | Coater & Stepper & Developer<br>• Process Flow<br>• Function of Coater module, Stepper, Developer<br>• Operation - recipes selection, machine operation<br>• Standard Operating Procedures<br>• Common error and trouble shooting<br>• Chemical handling, replenishing & resist bottle change explanation<br>• Hands-on running wafers<br>DUV<br>• DUV Process<br>• Operations -selecting recipes and machine operations<br>• Standard Operating Procedures<br>• Common error and trouble shooting<br>• Hands-on<br>CD Measurement<br>• Process function and equipment<br>• Operations - selecting recipes, machine operations<br>• Standard Operating Procedures<br>• Hands-on running lot and creating recipes |

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| | | • Common error and trouble shooting<br>Overlay<br>• Process function<br>• Operations - selecting recipes, machine operations<br>• Standard Operating Procedures<br>• Hands-on running lot and creating recipes<br>Inspection Microscope<br>• Operation-selecting recipes, running the instrument<br>• Standard Operating Procedures (SOP)<br>• Hands-on inspection on wafers and lots<br>• Common error and trouble shooting<br>Rework<br>• SOP on rework<br>• Reasons for rework<br>• Common error trouble shooting<br>• Hands-on<br>Lithography Statistical Process Control (SPC)<br>• SPC Data Collection<br>• Practical SPC - Best focus, flatness, Dose to Clear (DTC)<br>Swing curve<br>• Application<br>• Practical doing swing curve<br>Practical Running lots<br>• Practice running wafers on coater, stepper & developer, inspection, CDSEM and overlay. |
| | **Theory** | **Thin Film Process**<br><br>PECVD<br>• Process definition<br>• Process gases/control<br>• Process concepts/method (conformity and step coverage)<br>• Process applications (contact and vias)<br>• System hardware and configuration<br>• Common process issues and troubleshooting<br>• Machine operating/safety procedure(SOP)<br>• Process monitoring procedure/SPC<br>PVD<br>• Process definition<br>• PVD-Sputtering process definition and concepts<br>• PVD-Sputtering process methods<br>• Process concepts/method (conformity and step coverage)<br>• Process applications (contact and vias) |

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| | | • System hardware and configuration<br>• Common process issues and troubleshooting<br>• Machine operating/safety procedure(SOP)<br>• Process monitoring procedure/SPC<br>RTP<br>• Process definition<br>• Process gases/control<br>• Process concepts/method (conformity and step coverage)<br>• Process applications (contact and vias)<br>• System hardware and configuration<br>• Common process issues and troubleshooting<br>• Machine operating/safety procedure(SOP)<br>• Process monitoring procedure/SPC<br>CMP<br>• Process definition<br>• Process concepts/method (conformity and step coverage)<br>• Process applications (contact and vias)<br>• System hardware and configuration<br>• Common process issues and troubleshooting<br>• Machine operating/safety procedure(SOP)<br>• Process monitoring procedure/SPC |
| | **Practical** | • PECVD operations/application<br>• System hardware configuration and support systems<br>• recipe set up<br>• SOP<br>• process control and SPC procedure(test run & analyze)<br>• PM procedure, common errors and safety precaution<br>• Metrology tools operating system(surfscan, film stress, point probe and FTIR)<br>• PVD operations/application<br>• System hardware configuration and support systems<br>• recipe set up<br>• SOP<br>• process control and SPC procedure(test run & analyze)<br>• PM procedure, common errors and safety precaution<br>• Metrology tools operating system(surfscan, film stress and point probe )<br>• RTP operations/application<br>• System hardware configuration and support systems<br>• recipe set up<br>• SOP<br>• process control and SPC procedure(Lamp data,test run & |

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| | | analyze)<br>• PM procedure, common errors and safety precaution<br>• Metrology tools operating system(surfscan, film stress and point probe )<br>• CMP operations/application<br>• System hardware configuration and support systems<br>• recipe set up<br>• SOP<br>• process control and SPC procedure(test run & analyze)<br>• PM procedure, common errors and safety precaution<br>• Metrology tools operating system(surfscan and film thickness ) |
| | **Theory** | **Dry Etch & Reactive Ion Etch (RIE) Process**<br><br>• RIE & Plasma process and application<br>• RIE systems - AMAT & TEL<br>• Plasma systems – Kokusai<br>• Process problems and challenges<br>• Function of system components - RIE & Plasma systems<br>• Types of profile<br>• Structure of RIE chamber<br>• Parameters (Recipe)<br>• Measurement Tools<br>• Metrology tool<br>• Standard Operating Procedure (SOP)<br>• Process Control |
| | **Practical** | • Types of RIE systems/equipment<br>• Process Control Monitoring – SPC<br>• Metrology tools<br>• Endpoint monitoring (Understanding of endpoint traces communication)<br>• Process Control - visual inspection using microscope<br>• Recipe Setup - DPS and Plasma system<br>• Run SPC Etch rate test and particle test<br>• System configuration (DPS Chamber, Ceramic Dome Temp Control Unit and Electrostatic Chuck)<br>• Polysilicon etch - Application<br>o Poly etch & CD measurement<br>o Operation ET202<br>o Polysilicon etch - SPC<br>o SPC - Poly etch |

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| | | • Metal etch - Application<br>  ○ Metal etch & CD measurement<br>  ○ Operation ET201<br>  ○ Metal etch - SPC<br>• Plasma resist strip<br>  ○ Plasma resist strip SPC<br>  ○ Backside etch<br>• Oxide/Nitride etch - Application<br>  ○ Oxide/Nitride etch – SPC<br>  ○ Active/Contact etch & CD measurement<br>  ○ Via etch & CD measurement<br>  ○ Pad etch & CD measurement |
| | **Theory** | **Diffusion Processes**<br><br>Wet Processing<br>• Overview and definition (Wet Cleaning, Wet Etching and Solvent Clean)<br>• Machine hardware components and tank schematic drawings<br>• Process chemistries and chemical mixtures<br>• Wet process concept<br>• Factors affecting wet process<br>• Process recipe sequence and parameter setting<br>• Process application<br>• Wet etching vs dry etching<br>• Process control and SPC procedure<br>• Safety precaution<br>LPCVD and Atmospheric Furnace<br>• Machine hardware and components<br>• Process gases<br>• Process applications<br>  ○ Atmospheric: Dry ox, wet ox, implant drive in & anneal<br>  ○ LPCVD: Nitride, Undoped Poly, Insitu doped poly and HTO<br>• Recipe setup and process parameters<br>• Process control and SPC monitoring<br>• Safety precaution (gases hazards and high temperature hazards)<br>Ion Implantation Processes (High Current and Medium Current Implantation)<br>• Implanter hardware components, gases and safety precaution<br>• High vacuum concept<br>• Implant anneal and drive-in concept (ionization, extraction, |

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| | | analysis and acceleration )<br>• Implanter principal operation<br>• Implant process application and recipe set up (Boron, Phophorous & Arsenic)<br>• Implant process control and SPC procedure<br>• Safety precautions (Gases, high voltage and high current hazards) |
| | **Practical** | Wet Processing<br>• Machines hardware and configuration<br>• Machines operating procedure<br>• SPC monitoring procedure<br>• Run etch rate test, particle check, Rs and thickness measurement<br>• Recipe set up (create recipe, parameter setting, recipe sequence)<br>• Production lot processing procedure<br>• Common equipment errors and process issues<br>• Equipment error troubleshooting<br>• Equipment safety (chemical and mechanical hazards)<br>LPCVD and Atmospheric Furnace Processes<br>• Furnace hardware and support systems<br>• Furnace recipe set up<br>• Furnace operating procedure<br>• Furnace process control and SPC procedure<br>• PM procedure, common errors and safety precaution<br>Ion Implantation (High Current and Medium Current)<br>• Implanter hardware components, gases, PM procedure, common errors/ recovery and safety precaution<br>• Machine operating procedure<br>• Recipe selection, Ion beam set up and wafer load/unload<br>• Implant procedure<br>• Implant process control and monitoring (Particle check and Rs measurement)<br>Machine interlocks and safety features (hazards) |
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| | | **Equipment and Hardware Maintenance**<br>• Maintenance Management Systems<br>  ○ Planning and Scheduling<br>  ○ Preventive Maintenance |

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| 6 | **Theory** | ○ Improvement Activities<br>○ Predictive Maintenance<br>○ Equipment Specific Training<br>○ Spare Part Management<br>○ Budget<br>○ Maintenance Record<br>○ Equipment Life Cycle<br>• Safety Modules<br>○ Hazard Identifications<br>○ Personnel Protective Equipment<br>• Equipment Specific Modules<br>○ Vacuum Technology<br>○ RF/Microwave Theory and Applications<br>○ Electronics Control Systems<br>○ Leak Detection Tool<br>○ Troubleshooting Guide & Tips |
| | **Practical** | • System<br>○ User Interface<br>○ Subsystem<br>• Safety Modules<br>○ Hazard Identification<br>○ Safe Work Procedure<br>(ex: Magnetic/Toxic/Mechanical/Burn/High Voltage)<br>• Schematics Familiarization<br>○ Air / N2/ CDA Distribution Prints<br>○ Electrical Distribution (AC & DC)<br>○ Water Flow Prints<br>• Preventive Maintenance<br>○ PM Activity (Daily Checklists/ Monthly, Quarterly PM)<br>○ Subsystems Practical / Hands On |
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| | **Theory** | **Wafer Level Testing**<br><br>Parametric, Functional and Reliability<br>• Introduction to testing<br>• Important of reliability test<br>• Theory on Electro migration<br>• Hot Carrier Injection<br>• Gate Oxide Integrity Test<br>• Mobile Ions Degradation<br>• Manual measurement on transistor, diode, resistor and |

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| 7 | | capacitor.<br>• Auto test training on PCM |
| | **Practical** | • Manual measurement on transistor, diode, resistor and capacitor.<br>• Mobile Ions Integrity Manual Test<br>• Gate Oxide Integrity Manual Test<br>• Electromigration Manual Test<br>• PCM Auto testing via Agilent 4073 SPECS environment<br>  ○ Auto Prober handling<br>  ○ SPECS test setup<br>  ○ SPECS algorithm<br>• PCM Data Analysis (Wafer map, Distribution, CDF Plots etc)<br>• Auto Test Hot Carrier Injection via Agilent 4073 SPECS<br>  ○ Setup test via XHCI<br>  ○ Setup on SPECS<br>• Analysis Hot Carrier Injection via PDQ AT |
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| 8 | **Theory** | **Failure Analysis**<br>• Optical inspection<br>• Curve Tracer<br>• X-Ray – Theory and Introduction<br>• Scanning Acoustic Microscopy (SAM)<br>• Fault Isolation Photon Emission Microscopy/OBIRCH Fault Isolation Thermal Imaging Microscopy<br>• Sample preparation and polishing techniques<br>• Decapping process<br>• Scanning Electron Microscope (SEM)<br>• Energy Dispersive Spectrometer (EDS)<br>• Focused Ion Beam (FIB)<br>• Dual Beam<br>• Transmission Electron Microscope (TEM)<br>• Atomic Force Microscope (AFM) |
| | **Practical** | • Failure Analysis Flow<br>• Optical inspections and introduction to types of observation (Dark field, Bright field)<br>• Electrical Testing<br>• Non-destructive Testing using X-Ray machine |

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| | | • Non-destructive Testing using Scanning Acoustic Microscopy (SAM)<br>• Fault Isolation PEM/OBIRCH equipment operations<br>• Fault Isolation Thermal Imaging Microscopy equipment operations<br>• Sample preparation and Cross-Sectioning/polishing techniques<br>• Decapsulation process by chemical etching<br>• Scanning Electron Microscope (SEM) operations<br>• Energy Dispersive Spectrometer (EDS) operations<br>• Focused Ion Beam (FIB) operations<br>• Dual Beam operations<br>• Transmission Electron Microscopy (TEM) operations<br>• Atomic Force Microscope (AFM) operations |
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