

Program Records

About the Program

Abdullah Gül University (AGU) aims to be a research-oriented university with state-of-the-art facilities designed for multi-disciplinary research and graduate studies. AGU faculty with full experience in national and international research projects will produce benefits for all stakeholders. AGU pays special attention to building relationships with industry in order to establish efficient collaboration for qualified R&D projects.

The Electrical and Computer Engineering Department's MSc Program at AGU emphasizes advanced graduate education for cutting-edge research. Our research focuses on current high-growth fields like optics, photonics, nanotechnology, biomedical and bioinformatics, information and communications technology, power systems engineering, energy, control and automation.

All graduate students are encouraged to participate in funded research projects. Research projects are funded by TUBITAK, BAP, EU Framework Programs and industry. Applicants are strongly encouraged to apply for TUBITAK 2211 and TUBITAK 2215 scholarships. Internal funded scholarships will also be available for highly qualified candidates.

We believe that Electrical and Computer Engineering (ECE) MSc program at AGU will build its reputation based on the quality of its faculty members and graduate students. Bright, motivated and ambitious graduate students with renowned professors in their field will help to develop one of the best ECE programs.

Program Goals

By pursuing a graduate study in ECE program to attain an expertise in the offered fields and with their strong mathematics and physics background related to the advanced research topics; our students can

1. Conduct independent research and education activities at National and/or International industrial companies, R&D institutions and/or universities,
2. Follow latest developments in their field of expertise and contribute to the literature

Qualification Awarded

Master

Length of Program & Credits

2 (excluding one year of English Preparatory Program)
120 ECTS

Level of Qualification

Second Cycle (Master's) Degree; QF-EHEA: Level 2; EQF-LLL : Level 7

Mode of Study

Full Time

Field of Study

52- Engineering

Admission Requirements

An undergraduate diploma; a passing or acceptable score from the English Proficiency Exam of Abdullah Gül University, YDS (Foreign Language Exam), YÖKDİL (Foreign Language Exam for Higher Education Institutions), or TOEFL; an acceptable score from the Academic Personnel and Postgraduate Education Entrance Exam (ALES - Mathematical Score Type); a passing score at the oral interview for the concerned Master's program. International students are admitted based on the criteria posted by the university.

Recognition of Credit Mobility

Course Substitution: For course substitutions, medium of instruction of a previous course must be English, its final grade must be at least 3.00 out of 4.00 and approval of a relevant University Board is required.

Lateral Transfer: Spending at least one semester at the master's program



currently enrolled in, taking at least 2 credit courses and passing them with at least 3.00 out of 4.00.

Graduation Requirements & Regulations

Successful completion of 7 Courses, Seminar and Ethics; a minimum grade point average (GPA) of 3.00; earning 120 ECTS credits; successful submission of a thesis.

Occupational Profiles of Graduates The main mission of the Graduate School of the Engineering & Science of AGU is to develop highly qualified entrepreneurs, researchers, high-level managers and academicians.

In parallel with this mission, graduates of ECE program can be occupied as researchers or managers in the companies working in the filed like optics, photonics, nanotechnology, biomedical and bioinformatics, information and communications technology, power systems engineering, energy, control and automation; or they can be occupied in universities as researchers or academicians in universities to study in similar filed.

Access to Further Studies Graduates may apply to second cycle (Level 7 or Level 8) degree programs.

Assessment & Grading Policy Based on Abdullah Gul University Graduate Education and Examination Regulation rules;

<u>Letter Grade</u>	<u>Coefficient</u>	<u>Score</u>	<u>Status</u>	<u>Letter Grade</u>	<u>Status</u>
A	4,00	90-100	Pass	NA	Not Attended
A-	3,67	87-89	Pass	W	Withdrawn
B+	3,33	83-86	Pass	S	Satisfactory
B	3,00	80-82	Pass	U	Unsatisfactory
B-	2,67	77-79	Pass	P	In Progress
C+	2,33	73-76	Pass	EX	Exempt
C	2,00	70-72	Pass		
C-	1,67	64-69	Conditional Pass		
D+	1,33	56-63	Conditional Pass		
D	1,00	50-55	Conditional Pass		
F	0,00	0-49	Failed		

Program Outcomes

- PO1. The skills of using mathematics, science and engineering information in advanced research,
- PO2. The skills of analyzing, designing and/or implementing an original system that will be able to solve an engineering problem,
- PO3. The skills of using the required software, hardware and modern measurement equipments in their field of research,
- PO4. The skills of planning independent research and implementing in detail,
- PO5. The skills of following literature, listening to and making technical presentation, writing a paper in academic level,
- PO6. The skills of innovative and interrogative thinking and finding original solutions

TQF-HE & Program Outcomes Coverage	Knowledge	Skills	Competences			
	Theoretical Conceptual	Cognitive Practical	Work Independently and Take Responsibility	Learning	Communication and Social	Field Specific
P01	X	X		X		X
P02	X	X		X		X
P03	X	X	X	X		X
P04	X	X	X			X
P05	X	X	X	X	X	X
P06	X	X		X		X

Institutional & Program Outcomes Coverage	IO1	IO2	IO3	IO4	IO5	IO6	IO7
	P01	X	X			X	
P02	X	X			X	X	X
P03	X				X		X
P04	X				X	X	
P05			X	X		X	
P06		X	X				

Curriculum

(Semester 1) - Year 1

Course Code	Course Name	Theoretical Hours	Practical Hours	Credits	ECTS
ECEXXX	ECE Course	3	0	3	7,5
ECEXXX	ECE Course	3	0	3	7,5
ECEXXX	ECE Course	3	0	3	7,5
TOTAL		9	0	9	22,5

(Semester 2) - Year 1

Course Code	Course Name	Theoretical Hours	Practical Hours	Credits	ECTS
ECEXXX	ECE Course	3	0	3	7,5
ECEXXX	ECE Course	3	0	3	7,5
ECEXXX	ECE Course	3	0	3	7,5
TOTAL		9	0	9	22,5

(Semester 3) - Year 2

Course Code	Course Name	Theoretical Hours	Practical Hours	Credits	ECTS
ECE500	Seminar				5
ECE597	MSc Special Topics				10
ECE599	MSc Thesis				45
TOTAL					60

(Semester 4) - Year 2

Course Code	Course Name	Theoretical Hours	Practical Hours	Credits	ECTS
ECE	Ethic				7,5
ECE597	MSc Special Topics				10
ECE599	MSc Thesis				45
TOTAL					

Courses Descriptions

Code	ECE 501
Name	Linear Systems
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Spring
Type	Elective
Prerequisites	none
Content	The purpose of this course is to provide the students with the fundamental tools of linear system design, analysis, and control. The course content includes Introduction to Linear Systems, State-space representation and analysis, Solution for state-space linear time-invariant (LTI) systems, Controllability and Observability, State Feedback Control, Optimal Control, Stability, Discrete-time systems, Design Considerations and Steady-state accuracy, MIMO systems, Passivity, Polynomial representations and designs.

Code	ECE 506
Name	Advanced Theory of Power Electronics
Hour per week	3 (3+0)
Credit	3
ECTS	7,5
Level/Year	Graduate / Master, Ph.D.
Semester	Spring
Type	Elective
Prerequisites	EE 451 Power Electronics
Content	Fundamental concepts in Power Electronics. DC Machine Drives. E-Class Converter Operating Principles. DC Motor Control with E-Class Converter. Operating E-Class Converter as a DC/AC Inverter. Harmonic Reduction Techniques in Inverters. Voltage Source Inverters-VSI PWM Techniques, Advantages and Disadvantages. New VSI Techniques, Advantages and Disadvantages. Forced Commutated Converters and Inverters. Force "d Commutated Current Source Inverters-CSI. Resonant Power Converters

Code	ECE 510
Name	Architectures of Current and Future Internet
Hour per week	3 (3+0)
Credit	3
ECTS	7,5
Level/Year	Graduate / Master, Ph.D.
Semester	Fall
Type	Elective
Prerequisites	COMP 308 Computer Networks
Content	Explanation of the current and future Internet architecture will be given throughout the course. The main components and key mechanisms of the current Internet architecture like address resolution and routing will be investigated. Also, the Information Centric Networking (ICN), one of the key issues of the Future Internet paradigm will be discussed with its core concepts, potential architectures, and research directions.

Code	ECE 511
Name	Computer Networks
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall
Type	Elective
Prerequisites	none
Content	This course provides a comprehensive overview of computer networks and mobile communications technologies. The topics include computer networks, Internet, TCP/IP, transport layer protocols, routing layer protocols, medium access control protocols, wireless channel models, cellular networks and wireless local area networks. After completing the course, students will get a basic understanding about the computer networks and mobile communications, and related problem solving discipline using mathematics / engineering principles.

Code	ECE 512
Name	Wireless Sensor Networks
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Spring
Type	Elective
Prerequisites	none
Content	This course provides a comprehensive overview of wireless sensor networks and their real-world applications. The topics include wireless sensor network protocols, network architectures and management, error control techniques, optimal packet size design, cross-layer communication protocol solutions, localization algorithms, ZigBee, IEEE 802.15.4, 6LowPAN, underwater and underground sensor networks, wireless sensor and actor networks, and wireless multimedia sensor networks. After completing the course, students will get an advanced understanding about the wireless sensor networks and related problem solving discipline using mathematics / engineering principles.

Code	ECE 513
Name	Introduction to Robotics
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall
Type	Elective
Prerequisites	none
Content	The purpose of this course is to provide the students with the fundamental tools of robotic system design, analysis, modeling, and control. The course content includes robot classifications, Rigid motions, Homogeneous transformations, Robot forward kinematics, Robot inverse kinematics, Differential kinematics and Jacobians, Motion planning and trajectory generation, Robot dynamics, Mobile robots, Independent joint control, and Robot sensors and actuators. The course provides self-learning and creative thinking abilities.

Code	ECE 520
Name	Flat Panel Display Technologies
Hour per week	3+0 (Theory + Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate / M.Sc.-Ph.D.
Semester	Fall-Spring
Type	Elective
Prerequisites	General Semiconductor Physics and Electronics Engineering Background
Content	Displays overview, Color science and engineering, Photo-physical mechanisms, Liquid crystal displays, Liquid crystal displays, Organic light emitting diodes and displays, Plasma displays, Field emission displays, Electroluminescent displays, Future of the display technology

Code	ECE 521
Name	Geometrical Optics
Hour per week	3+0 (Theory + Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall, Springs
Type	Elective
Prerequisites	None
Content	Ray optics and Fermats' principle aberration and dispersion in optical systems, thin lens equations, ray tracing, Gaussian beam propagation, interference of light, single and double slit interference, optical resonators and their types and applications, modulation of light and modulation devices.

Code	523
Name	Photonics
Hour per week	3+0 (Theory + Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall
Type	Elective
Prerequisites	None
Content	Photonics course intends to focus on basic concepts of light and photonics with their applications. This course includes contents from electromagnetic spectrum and its properties; beam optics and beam propagation; polarization of light; generation and detection of light; modulation of light via electro optic and acousto optic modulators; fiber optic cable and transmission of light through fiber optic cable.

Code	ECE 524
Name	Fiber optic communication
Hour per week	3+0 (Theory + Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Springs
Type	Elective
Prerequisites	None
Content	In this course, the fiber optic communication links and the sub components will be covered. The content of this course is: optical transmitters and receivers,

fiber optic based amplifiers, fiber optic cable properties and types, modulation of light, power budget in optical fiber links and multi channel systems.

Code	ECE 530
Name	Digital Image Processing
Hour per week	3 (Theory)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall, Springs
Type	Elective
Prerequisites	
Content	The principle objectives of this course are to provide an introduction to basic concepts and methodologies for digital image processing, and to develop a foundation that can be used as the basis for further study and research in this field.

Code	ECE543
Name	Fundamentals of BioMEMS
Hour per week	3 (Theory)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall
Type	Elective
Prerequisites	
Content	<ul style="list-style-type: none"> • Fundamentals of instrumentation • Anatomy terms • Protein, DNA, Cell and cell membrane • Origin of bio-signals. • Circulation, neural and muscle systems • Transducers, and instrumentation circuitry • Classification of bio-signals and fundamental features • Bio-signal processing • Frequency Domain characterization • Frequency domain analysis, FFT, filtering artifact removal

Code	Electric Power Distribution System Engineering
Name	ECE 553
Hour per week	3(3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall, Springs
Type	Elective
Prerequisites	
Content	Power distribution system modeling, primary and secondary system, voltage control and capacitor control and usage of a programming language during the course of these analyses will be aimed. At the end of the course, student will learn how to analyze distribution systems in general, load characteristics and nature of loads, application of distribution transformers, design of sub transmission lines and distribution substation, design considerations of primary systems, design considerations of secondary systems, voltage drop and power loss calculations, application of capacitors to distribution systems, distribution system voltage regulation, power system harmonics.

Code	ECE 555
Name	Advanced Theory of Electrical Machines
Hour per week	3 (3+0)
Credit	3
ECTS	7,5
Level/Year	Graduate / Master, Ph.D.
Semester	Fall
Type	Elective
Prerequisites	None
Content	DC motor transient and steady state equations, Derivation of transfer functions of DC motor, Controller design for dc motor control, Review of induction machine theory, Derivation of equivalent circuits of induction machine, Derivation of equivalent circuit used in the field oriented controlled induction machine, Analysis of induction machine in per-unit system, Equivalent circuit of induction machine used in the transients, Analysis of induction machine for unbalanced cases with symmetrical components, Analysis of induction machine for non-sinusoidal supply cases by means of harmonic equivalent circuit.

Code	ECE 560
Name	Neural Networks
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate / anytime
Semester	Fall - Spring
Type	Elective
Prerequisites	-
Content	This course provides an introduction to neural networks. It covers single and multi-layer networks, backpropagation algorithm, network training algorithms, regularization, Bayesian neural networks, self organizing maps and extreme learning machine. The course also provides applications of neural networks for classification, regression, clustering and feature selection. Methods will be implemented by a neural network software and applied on various machine learning problems.

Code	ECE 561
Name	Bioinformatics
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate / anytime
Semester	Fall - Spring
Type	Elective
Prerequisites	-
Content	This course introduces computational techniques for mining the large amount of information produced by recent advances in molecular biology, such as genome sequencing and microarray technologies. Together with the minimal biological background necessary for a computer-engineering student, some of the most basic and useful algorithms for sequence analysis and their applications to current genomics research will be presented. Topics to be covered also include clustering and classification algorithms for the analysis of gene expression data, methods to analyze large scale biological networks.

Code	ECE 562
Name	Machine Learning
Hour per week	3 + 0 (Theory + Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate / 1, 2, 3, 4
Semester	Fall, Spring
Type	Elective
Prerequisites	Introduction to Computer Programming, Probability and Statistics, Linear Algebra
Content	The course provides a broad introduction to the techniques that enable computers to learn from and make predictions on data. Fundamental learning methods will be covered including classification, regression, linear models, neural networks, support vector machines, dimension reduction, ensembles, and advanced learning techniques. Methods will be implemented by a machine learning software and applied on various learning problems.

Code	ECE 565
Name	Data Mining
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate / anytime
Semester	Fall
Type	Elective
Prerequisites	-
Content	This course provides an introduction to data mining. It covers data representation, data preprocessing, fundamental pattern discovery techniques such as frequent itemset and association rule detection, and basic concepts of classification and clustering algorithms. This course also presents performance evaluation and testing methods of classification algorithms. Through a course project, the students will program a data mining software and apply the concepts to a real problem.

Code	ECE 576
Name	Nonlinear Control
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall/Spring
Type	Elective
Prerequisites	none
Content	The purpose of this course is to provide the students with the fundamental tools of nonlinear system design, analysis, modeling, and control. The course content includes Review of Linear Control Systems, Introduction to Nonlinear Systems, Second and Higher Order Systems, Input-State and Input-Output stability, Nonlinear Forms, Stabilization with Feedback Control, Robust Stabilization with Feedback Control, Tracking with feedback control, Observers for State-Feedback Control, Integral Control, Passivity. The course provides self-learning and creative thinking abilities.

Code	ECE581
Name	Computer Architecture
Hour per week	3 (3 Theory + 0 Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Springs
Type	Elective
Prerequisites	-
Content	This course provides the major concepts and design philosophies of computer architecture and explains the principles, tradeoffs, and implementation details of microprocessors. The course introduces the basic mechanisms such as pipeline, branch prediction, multi-threaded execution which are utilized in the current state of the art microprocessors. Also, laws of performance evaluation of a modern computer will be explained in the course to measure if a computer meets functional, performance, energy consumption, cost, and other specific goals. After completing the course, students will get a basic understanding about the topics relevant to design of microprocessors of the present and will be able to foresee problems and possible solution directions for the future architectural designs.

Code	ECE582
Name	Parallel Architectures
Hour per week	3 (3 Theory + 0 Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Springs
Type	Elective
Prerequisites	-
Content	The main objective of the course is to build a strong understanding of the fundamentals of the architecture of parallel computers and the tradeoffs made in their design. Parallel computers are now almost everywhere and different types of parallelisms are exploited in the computer hardware. These parallelisms, such as, multi-core architectures, parallel memory systems, vector architectures, dataflow machines, and interconnection networks will be explained in the class.

Code	ECE 585
Name	Semiconductor Device Fundamentals
Hour per week	3+0 (Theory + Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate / M.Sc.-Ph.D.
Semester	Fall-Spring
Type	Elective
Prerequisites	General Semiconductor Physics and Electronics Engineering Background
Content	Crystal structure-atoms and electrons, Energy bands and charge carrier in semiconductors, Optical absorption, luminescence, carrier lifetime and diffusion, Junctions, Field effect transistors-Bipolar junction transistors, Photodiodes, Light emitting diodes, Solar cells, Lasers

Code	ECE 589
Name	Interdisciplinary Introduction to Quantum Engineering
Hour per week	3 (Theory)
Credit	3
ECTS	7,5
Level/Year	Graduate / 1, 2
Semester	Fall
Type	Elective
Prerequisites	None
Content	Interdisciplinary introduction to basic concepts of modern engineering of small scale objects; Learning the social impact of modern engineering; Learning the role of modern engineering in the solution of global challenge problems. The course covers: basic principles of quantum approach to modern engineering; concepts of engineering for quantum dots, wires, wells and nanoscale objects; concepts of special and energy control of small scale objects; basic concepts of quantum computation and quantum communication; application of quantum engineering to bio- and medical technologies; social impacts of quantum engineering; role of quantum engineering in the developing of modern and forthcoming technologies; contribution of quantum engineering to solving global challenge problems.

Code	ECE 607
Name	Design of Variable Reluctance Machines
Hour per week	3 (3+0)
Credit	3
ECTS	7,5
Level/Year	Graduate / Master, Ph.D.
Semester	Fall
Type	Elective
Prerequisites	EE 308 Electrical Machines and Drives
Content	Fundamentals of VRM Analysis. Practical VRM Configurations. Current Waveforms for Torque Production. VRM Drives. Nonlinear Analysis. Performance Analysis of VRMs and VRM Drives by Software Simulations. Loss, Efficiency and Torque Calculations. Paper Reviews on the Subject. Evaluation of Selected Studies Carried on Reviewed Papers by means of Software Simulations. Step Motors. Various Configurations of Step Motors. Step Motor Control Methods and Step Motor Drives. Paper Reviews on the Subject.

Code	ECE 608
Name	Theory of Field Orientation Control
Hour per week	3 (3+0)
Credit	3
ECTS	7,5
Level/Year	Graduate / Master, Ph.D.
Semester	Fall
Type	Elective
Prerequisites	ECE 550 Advanced Theory of Electrical Machines
Content	Vector Control and Field Orientation in Synchronous Machines. Current and

Torque Control via CSI and PWM Drives. Torque Control via Current Regulated PWM Drive. Vector Control and Field Orientation in Induction Machines. Independent Flux and Torque Control. Induction Machine Flux and Torque Control via CSI, PWM, and CRPWM Drives. Slip Calculator and Its Errors. Direct and Indirect Field Orientation. DQ Model of Induction Machines. Stator, Rotor, Synchronous and Arbitrary Reference Frames and Induction Machine Models in Various Reference Frames. Complex Vector Notation. Complex Vector Models of Induction Machine. Digital Computer Simulation and Analysis of Induction Machines by means of Developed Models. Paper Reviews on the Subject. Evaluation of Selected Studies Carried on Reviewed Papers by means of Software Simulations.

Code	ECE641
Name	Fundamentals of BioMEMS
Hour per week	3 (Theory)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall
Type	Elective
Prerequisites	
Content	<ul style="list-style-type: none"> • Nanotechnology and its applications • Materials and specifications • Fabrication Process: Etching, Deposition and patterning • Surface properties • Nanotechnology based transduction • Microfluidics • Micro/nano biosensors • Standard laboratory methods • Micro/nano cantilevers • Biochips • Application of MEMS to medicine and biology

Code	ECE 645
Name	Biosensors
Hour per week	3 (Theory + Practice)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall/Springs
Type	Elective
Prerequisites	
Content	<ul style="list-style-type: none"> • Nano/Micro technology applications for Biosensing • Materials and specifications • Surface properties • Transduction mechanisms • Microfluidics • Micro/nano biosensors • Standard laboratory methods for biosensing • Cantilever/Carbon Nanotube Biosensors • Target based Biosensing

Code	ECE 652
Name	Advanced Power System Analysis
Hour per week	3(3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall, Springs
Type	Elective
Prerequisites	NA
Content	Power system modeling, power flow calculation and short circuit studies and learning of usage of a programming language during the course of these analyses will be aimed. At the end of the this class, student will learn how to analyze power system in general, there phase system and connection (delta-y), power systems in per-unit system, admittance matrix modeling and usages, derivation of network reduction, derivation of Z bus modification, power Flow Calculation by using gauss-seidel and newton Raphson methods, symmetrical and unsymmetrical components, short circuit calculation, economic operation of power systems.

Code	ECE 654
Name	Power System Stability
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Fall, Spring
Type	Elective
Prerequisites	ECE 652
Coordinator(s)	Assoc. Prof. Dr. Ahmet Onen
Content	This course intends to teach the students power system stability problem and handling, creating controller for stability issues and usage of a programming language on power system applications. The course covers the following topics: Introduction to power system structures and simulation, Synchronous machine modeling, Excitation system modeling, Turbine-Governor modeling, Interconnected multi-machine modeling, Transient stability analysis, Linearized modeling and the control problem, Signal analysis, Power System Stabilizer (PSS) design, Voltage Stability, Frequency Stability.

Code	ECE 686
Name	Semiconductor Process and Device Fabrication
Hour per week	3 (3+0)
Credit	3
ECTS	7,5
Level/Year	Graduate / Master, Ph.D.
Semester	Spring
Type	Elective
Prerequisites	None
Content	This course introduces the fundamentals of microfabrication process and reviews the developments, materials and clean room protocols. The topics are photolithography, masking and patterning of materials, semiconductor oxidation and diffusion, ion implantation, thermal processing, etching, metal and dielectric deposition for contacts, gate and interconnect engineering, metrology and process control systems, packaging, MEMS devices.