RESEARCH PLAN

Faculty of Engineering- Cairo University
Graduate Studies and Research Sector
Research Plan 2019-2024

2019-24

www.eng.cu.edu.eg

JUNE 2019 EDITION

Faculty of Engineering – Cairo University

Graduate Studies and Research Sector

Research Plan 2019 – 2024

June 2019

Contents

Introduction

Research Directives of the Faculty of Engineering – Cairo University as Related to the National Strategy for Science, Technology and Innovation-2030

The research directives of the Faculty of Engineering-Cairo University (CUFE) are in conformity to the first track of the National Strategy *"Creating an inspiring and supportive environment for excellence and innovation in scientific research as foundation for comprehensive societal development and to produce new areas of knowledge to attain international leadership"*. This is achieved through exceptional research in all fields of Engineering published in internationally acclaimed journals, in addition to local and regional ones. CUFE research deals with sustainable and innovative problem solving while targeting cooperation with local and international research partners. The main aim is to produce graduates capable of dealing with research challenges and to practice engineering in accordance with the market demand. CUFE faculty are distinguished in that many have high publication metrics.

CUFE research plan integrates the fourteen departments of the faculty and conforms to the second track of the National Strategy *"Producing knowledge and technology transfer and localization"*. Some overlap is evident among the different departments to achieve the directives in the National strategy. All CUFE departments are supported by the Engineering Mathematics and Physics Department as it is the cornerstone on which applied and advanced research in all fields is based.

The position of the research targeted by CUFE departments with respect to the National Strategy is detailed below.

First Directive: Energy

Under the **second objective** the research of the Mining, Petroleum and Metallurgy Department focuses on increasing the dependence on local resources, while under the **third objective** the research of both Mechanical Power Engineering and Mechanical Design and Production Engineering Departments is directed towards reducing energy consumption. Under the **fifth and sixth objectives** the Engineering Mathematics and Physics Department research focuses on modeling and designing innovative solar cells that are used in energy harvesting, generation, and storage in addition to studying the thermal dynamic systems related to the generation of wind energy as a renewable source of energy. Also interested in the above two objectives are the Electrical Power Engineering Department from the prospect of solar energy production by increasing its efficiency and storage capabilities and integrating the produced energy to the National grid; both Mechanical Power Engineering and Mechanical Design and Production Engineering Departments from the aspect of the production of energy from wind and increasing its engines efficiency. The Mechanical Power Engineering Department also focuses on design optimization of solar and wind energy systems and components as well as building energy consumption optimization. Both the Architectural Engineering and Structural Engineering Departments perform research from the aspect of finding new and innovative materials to be used in the structures and buildings of new and renewable energy facilities. Under the **seventh objective** the research of the Engineering Mathematics and Physics Department targets energy production from high waves that are abundant near the Northern and Western coasts of Egypt while the research of the Irrigation and Hydraulics Engineering Department is concerned with maximizing the utilization of tidal energy, and the theoretical and experimental research of the Chemical Engineering Department is directed towards maximum utilization of biomass and algae to produce renewable energy. Under the **eighth objective** the research of the Electrical Power Engineering Department focuses on combining renewable and non-renewable traditional sources of energy.

Second Directive: Water

Owing to its specialization, the research of the Irrigation and Hydraulics Engineering Department covers the five objectives of this directive. The rest of the departments' research fall under one or more of these objectives. Under the **fourth objective** the research of both Mechanical Power Engineering and Chemical Engineering Departments aims to conserve industrial water usage and together with the Mechanical Design and Production Engineering Department under the **fifth objective** the combined research targets the development of desalination technologies from the aspects optimization of the different processes and their suitability for seawater, brackish water, and wastewater desalination.

Third Directive: Health

In view of its specialization, the research of the Systems and Biomedical Engineering Department focuses on the **second objective** through healthcare engineering and management, medical imaging, medical equipment manufacturing and maintenance.

Fourth Directive: Agriculture and Food

In view of its specialization, the research of the Irrigation and Hydraulics Engineering Department under the **fifth objection** is directed towards combating improper use of water resources and under the **second and ninth objective** the research of both Mechanical Power Engineering and Mechanical Design and Production Engineering Departments is directed towards contributing with detailed designs for the equipment and their manufacture. Under the **fifteenth** objective the research of the Chemical Engineering Department is directed towards extraction of valuable products from the wastes of the agricultural industry.

Fifth Directive: Protecting the Environment and Natural Resources

A common research path for the Irrigation and Hydraulics, Chemical, and Aerospace Engineering Departments under the **first objective** is the utilization of climate change studies to develop methods to decrease its harmful potential. Accordingly, the research of the Irrigation and Hydraulics Engineering Department focuses on the dynamic mathematical modeling of climate and climate change on a regional level while studying its effect on water resources and sea level rise and its effect on coastal areas and the Nile Delta. The interest of the Chemical Engineering Department research lies in the modeling of air pollutants to predict their effect on climate change while studying the effect of the different sources on the air quality and thus attempt to find effective ways to minimize pollutants from major polluters. The research of the Electrical Power Engineering Department is directed towards the electromagnetic pollution issue through modeling and measuring the electromagnetic waves to protect the environment and minimize the risks associated with these waves. Under the **third objective** the research of both the Architectural Engineering and Irrigation and Hydraulics Engineering Departments is directed towards providing a clean and sustainable environment and also under the **fourth objective** by promoting and supporting a green economy. Also interested in this objective is the research from the Architectural Engineering, Structural Engineering, Chemical Engineering, Mechanical Power Engineering, and Mechanical Design and Production Engineering Departments in an attempt to change traditional production methods into those that do not affect the environment. In view of its specialization, the research of the Mining, Petroleum and Metallurgy Engineering Department targets the conservation of natural resources.

Sixth Directive: Technological Applications, Futuristic and Interdisciplinary Sciences

All CUFE departments are interested in building new potentials through research and development in interdisciplinary and interconnected and futuristic fields such

as artificial intelligence and robotics application in industry by the Electrical Power Engineering and Computer Engineering Departments. Nano-technology applications are the concern of Public Works, Electrical Power Engineering, Mining, Petroleum and Metallurgy Engineering, and Chemical Engineering Departments. Biotechnology is tackled through both Irrigation and Hydraulics Engineering and Chemical Engineering Departments. Bioinformatics is addressed by Systems and Biomedical Engineering, Electronics and Electrical Communications Engineering, and Computer Engineering Departments.

The research of both the Structural Engineering and Mechanical Design and Production Engineering Departments focus on the **first specific objective** by merging technologies that boost integration between decentralized and smart production facilities. Under the **third specific objective** the research of the Engineering Mathematics and Physics Department specializes in investigation of carbon nanotubes and nanostructures. Under the **fourth specific objective** the research of the Aerospace Engineering Department is directed to space technology and its usage in aerial and remote sensing which is also a research interest of the Public Works Department. The Engineering Mathematics and Physics Department research contributes towards achievement of the **fifth specific objective** by attempting to solve cancerous cell dispersion and modeling of neural cells. The Mechanical Design and Production Engineering Department is concerned with developing methods and equipment for the detection and removal of mines in collaboration with interested stakeholders to cover the **sixth specific objective**.

Seventh Directive: Strategic Industries

All CUFE departments contribute towards the development of the National industry by promoting local manufacturing to overcome the existing technological gap. Both Mechanical Power Engineering and Mechanical Design and Production Engineering Departments collaborate under the **first objective** through studies to develop National industries and under the **fourth objective** to develop silicon, graphene, and mineral resources, and under the **fifth objective** by promoting local

manufacturing. Under the **sixth objective** the Chemical Engineering Department is focused on developing the chemical industry while both Electronics and Electrical Communications Engineering and Computer Engineering Departments focus on developing the electronics industry under the **seventh objective.** Also, the Engineering Mathematics and Physics Department research is directed towards strategic applied technologies from the point of view of providing safe imaging processes, quality control, and imaging to detect hidden weapons.

Under the **first specific objective** the Mechanical Design and Production Engineering Department is occupied with spreading the Made in Egypt motto. All CUFE departments are engrossed with applying the **fourth specific objective** aware that twinning and technology transfer between industry and academia is the future.

The Mechanical Design and Production Engineering Department encourages local manufacturing in the diverse fields of energy, water, electronics, communication, agricultural equipment, robotics, and spare parts under the **tenth specific objective** and in the meantime under the **eleventh specific objective**, it seeks funding for international collaboration projects promoting development and innovation for silicon, graphene, and mineral resources.

The interest of Mechanical Power Engineering, Chemical Engineering, and Aerospace Engineering Departments lie under the **twelfth specific objective** in order to discover alternative sources of energy and to conserve energy consumption. Another focus of the Electronics and Electrical Communications Engineering, Computer Engineering, and Mechanical Design and Production Engineering Departments lies under the **thirteenth specific objective** to enhance Egypt's role in electronics design.

A major research interest of the Mechanical Design and Production Engineering Department falls under the **fourteenth specific objective** to build on Egyptian capabilities by conducting innovative research and develop the nano-scale industry through mechatronics. It also encourages increasing competitiveness through local

manufacture of equipment, agricultural machines, spare parts, casts, industries supporting the automotive industry, desalination and robotics under the **sixteenth specific objective**. It is also focused under the **seventeenth specific objective** on linking equipment production facilities to the advanced designs carried out in local universities and research and technological centers to enhance technological development.

As for the specific objectives related to the different enlisted strategic industries, both Mechanical Design and Production Engineering and Mining, Petroleum and Metallurgy Engineering Departments are keen to develop silicon, graphene, and mineral resources under the **fourth objective** to raise the quality of local mineral resources for the Egyptian industries and to increase their added value. All objectives of the chemical industries are one of the major concerns of the Chemical Engineering Department in order to reach self-sufficiency in the production of fertilizers, offer alternative sources of energy and conserve its utilization in the chemical process industries. Both Electronics and Electrical Communications Engineering and Computer Engineering Departments endeavor to position Egypt among the leading countries in the field of electronics industry.

Eighth Directive: Information and Communication Technology

The center of gravity of the research interest of the Engineering Mathematics and Physics, Electronics and Electrical Communications Engineering, Electrical Power Engineering, Systems and Biomedical Engineering, and Computer Engineering Departments is in narrowing the digital and information gap to empower information and communication technology. The Structural Engineering Department is focused under the **first objective** to model building information in order to enhance the communication database between industry and the electronic Government. Also, under the same objective but from different aspects lie the interests of both Engineering Mathematics and Physics and Computer Engineering Departments. These aspects include artificial intelligence, machine learning, big data analytics, cyber security, data security and encryption.

Ninth Directive: Education is National Security

The main objective of all CUFE departments is to produce graduates with the skills to innovate, create and excel on both the local and international levels.

Eleventh Directive: Investment, Trade and Transportation

In view of its specialization, the center of gravity of the research interest of the transport group of the Public Works Department lies under the **third objective** to maximize possible benefits from the transport sector and Egyptian ports by developing the management and operation system to raise the levels of safety in the railway sector. Also, the ability to predict the size of the demand on the different transport sources and ports (land, marine, aerial) and to develop an integrated transport network. The Structural Engineering Department also addresses the same objective by developing modern structural and building systems for the different kinds of bridges. Also, under the **fourth objective** both Public Works and Irrigation and Hydraulics Engineering Departments endeavor to raise the efficiency of logistical service and offering integrated solutions in the supply chain management in addition to developing possible measure to ease public transport within the Egyptian cities.

Twelfth Directive: Tourism Industry

In view of its specialization, the Architectural Engineering Department is concerned with the **eighth specific objective** through enforcing novel academic and practical approaches to heritage conservation and management of its sites to enable sustainable tourism development. Also, the structural Engineering Department offers research in the field of methods of support and rehabilitation of heritage structures and buildings.

Main Features of Graduate Studies and Research

The Faculty of Engineering at Cairo University (CUFE) is considered one of the educational and research institutions with a positive and significant impact on the higher education and scientific research sectors locally, regionally and internationally. The diverse fields of specialization, the capabilities of both faculty and graduate students, theses produced and internationally published research work attribute to CUFE's strength. CUFE faculty are acclaimed on the international, regional and local levels having been awarded many prestigious prizes. Accordingly, CUFE maintains an honorable rank in world university rankings. Table 1 shows the evolution of the world ranking of CUFE according to the British QS ranking for the past three years while Table 2 details the ranking of the various engineering subjects within the 2019 QS world university rankings.

Table 1: The QS World University Ranking of CUFE

Year	2017	2018	2019
Rank	246	231	236

Table 2: 2019 QS World University Ranking of CUFE by Subject

Subject	Global Rank	Domestic Rank
Architecture/Built Environment	151-200	2
Civil & Structural	101-150	1
Mechanical, Aeronautical & Manufacturing	251-300	1
Electrical & Electronics	201-250	1
Chemical	151-200	1
Computer Science & Information Systems	151-200	1

1- Graduate Degrees

CUFE offers over 60 M.Sc. and 20 Ph.D. programs in addition to approximately 70 diploma programs (not all offered at the same time). Most of the theses attempt to address either national challenges, modern technology, or advanced research

topics. CUFE supports the different research facets through its vast research and laboratory capabilities. Energy, water, environment, IT applications are among the national challenges tackled by the theses issued by CUFE.

2- Human Potential

Distinguished faculty and graduate students enrich CUFE's human capabilities and resources.

2-1 Faculty and Academic Experience

CUFE includes a distinguished group of faculty and teaching assistants who drive the educational process, scientific research and graduate studies. Research at CUFE started since the 1940s, where M.Sc. and Ph.D. degrees were awarded to many prominent figures in the society. CUFE also contributed to the graduation of Engineering faculty in other local, regional, and some international universities.

Table 3 shows the evolution of the actual workforce of faculty and teaching assistants during 2014-2018 while Figure 1 presents the actual 2018 workforce in the different departments. In the five years period 2013-2017, 15 faculty were awarded the State Prize (Encouragement - Excellence - Appreciation - Nile / Mubarak), one faculty won the 2015 Pioneer Award, and one faculty won the 2017 Women's Encouragement Award. Also, during the same period, 16 faculty won Cairo University Awards (Encouragement - Excellence - Appreciation - Distinction).

Table 4 presents the number of state prizes won by CUFE faculty during the last five years while Table 5 shows the number of Cairo University awards won by faculty during the same period. Cairo University awards encouragement and scientific excellence prizes in seven different scientific fields (1-3 awards in each field based on the number of applicants) and awards eight appreciation prizes also in different fields.

Table 3: Actual Faculty and Teaching Assistants Workforce, 2014-2018

Year	No. of Faculty	No. of Teaching Assistants	Total
2014	903	413	1316
2015	911	443	1354
2016	890	382	1272
2017	910	350	1260
2018	747	318	1055

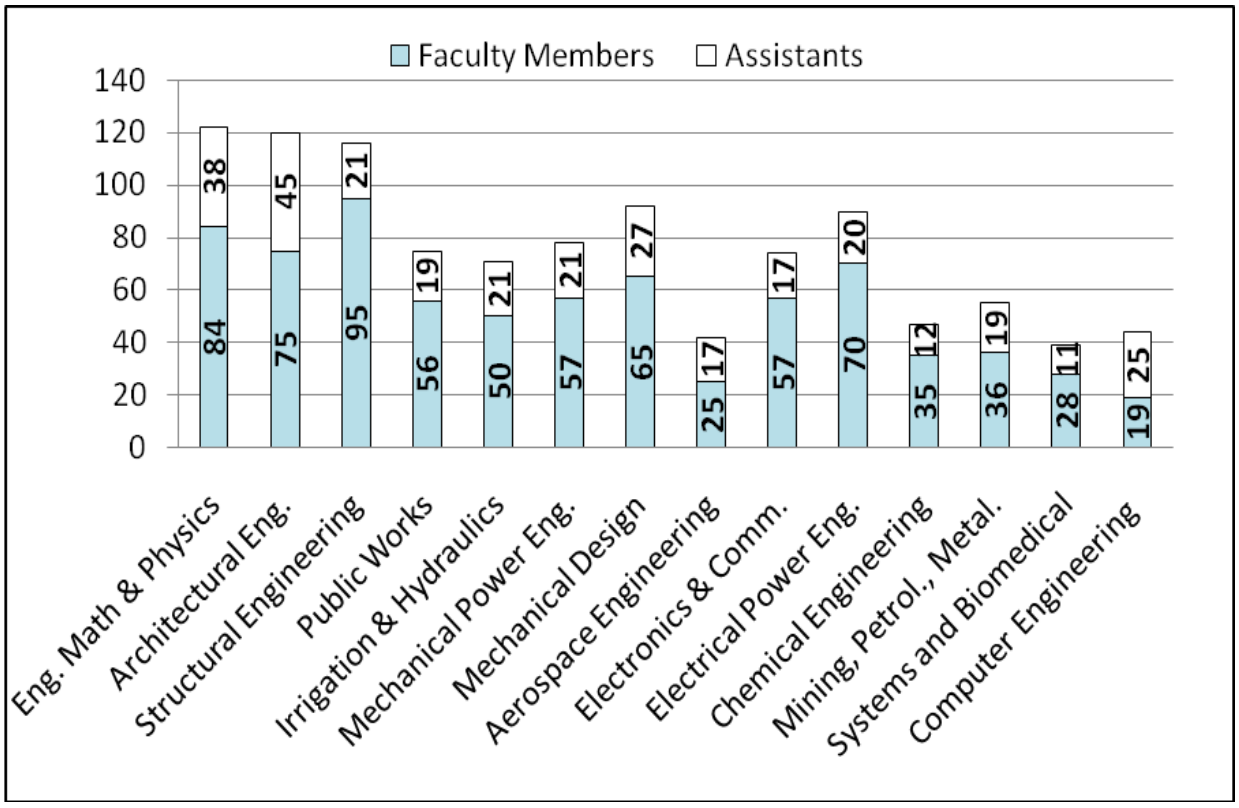

Figure 1: Actual faculty and teaching assistants workforce in the various departments during 2018

Table 4: Distribution of State Awards in CUFE, 2013-2017

Year	Award				
	Encouragement (Total:40)	Excellence (Total: 5)	Appreciation (Total: 9)	Nile/Mubarak (Total: 2)	Total
2013	—	—	—	—	—
2014	1	—	2	—	3
2015	4	—	1	—	5
2016	2	—	2	—	4
2017	2	—	1	—	3
Total	9	—	6	—	15

Table 5: Distribution of Cairo University Awards in CUFE, 2013-2017

Year	Award				
	Encouragement (Total:7-21)*	Excellence (Total: 7-21)*	Appreciation (Total: 8)	Distinction (Total: 7)	Total
2013	1	1	—	1	3
2014	—	—	—	—	—
2015	1	—	—	—	1
2016	1	2	1	2	6
2017	2	1	2	1	6
Total	5	4	3	4	16

* 1-3 awards in seven different scientific fields based on the number of applicants

2-2 Graduate Students

The number of enrolled students in the graduate stage exceeds 5,000. Table 6 outlines the evolution of the number of M.Sc. and Ph.D. students in the past five years while Figure 2 shows the number of students enrolled in the different departments for the academic year 2018/2019.

Table 6: Number of Graduate Students (M.Sc. and Ph.D.), 2014-2019

Year	No. of M.Sc. Students	No. of Ph.D. Students	Total
2014/2015	4085	1502	5587
2015/2016	4128	1378	5506
2016/2017	4619	820	5439
2017/2018	4487	942	5429
2018/2019	4503	860	5363

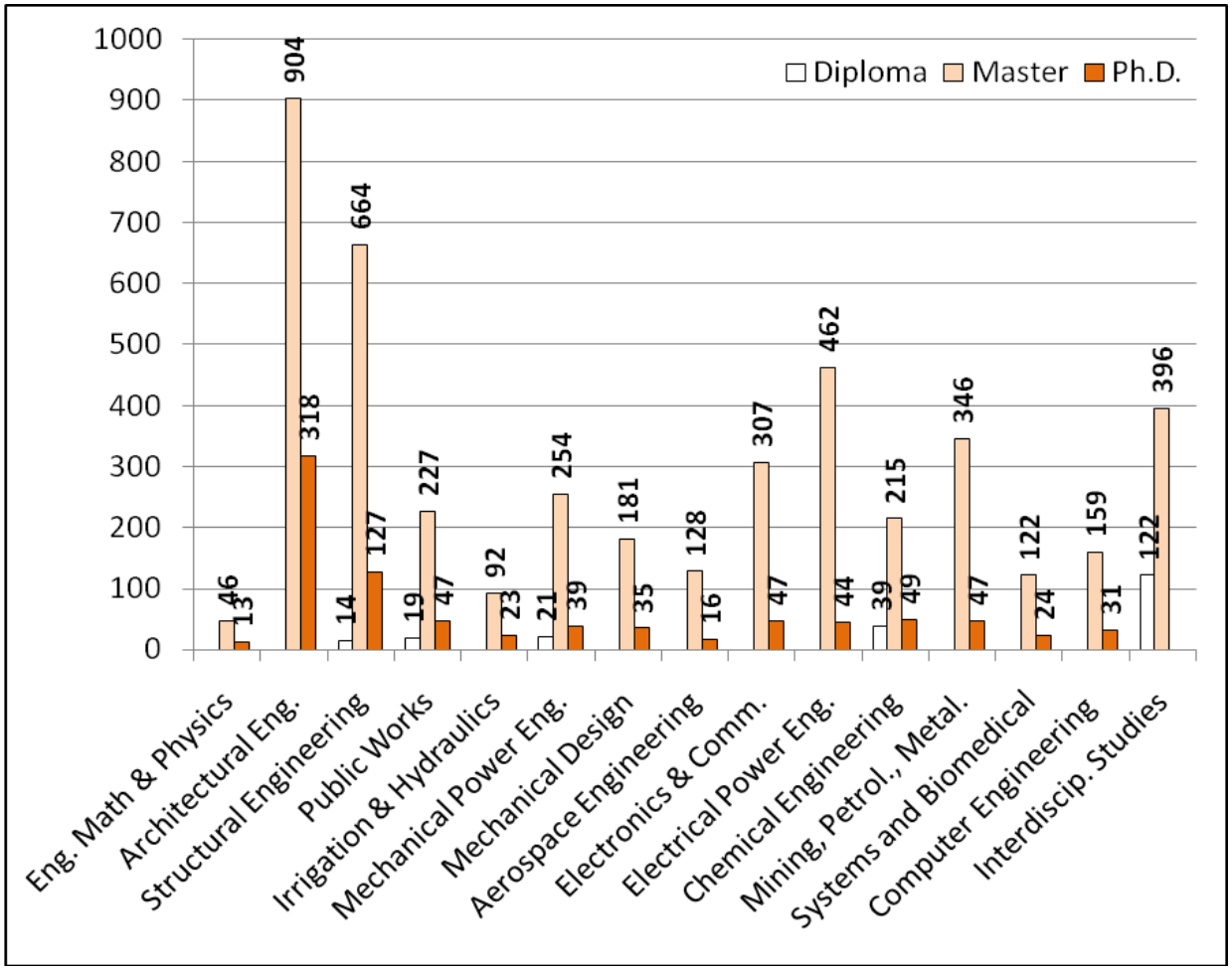

Figure 2: Number of graduate students by department during the academic year 2018/2019

3- Scientific Contribution

The scientific contribution of graduate studies and research at CUFE includes scientific dissertations and published research.

3-1 Scientific Theses

The graduate theses offer a methodology for solving problems of the different engineering sectors or to promote their own research. Table 7 shows that there is a relative stability in the number of M.Sc. and Ph.D. degrees awarded by CUFE over the past five years. It is seen from the table that about 400 M.Sc. and 100 Ph.D. degrees are awarded annually. Figure 3 shows the numbers of Ph.D. degrees awarded in the various departments in 2018 while Figure 4 shows the numbers of M.Sc. degrees awarded in the different departments for the same year.

Table 7: Numbers of M.Sc. and Ph.D. Degrees Awarded, 2014-2018

Year	No. of M.Sc. Degrees	No. of Ph.D. Degrees	Total
2014	344	106	450
2015	389	91	480
2016	411	103	514
2017	382	95	477
2018	382	109	491

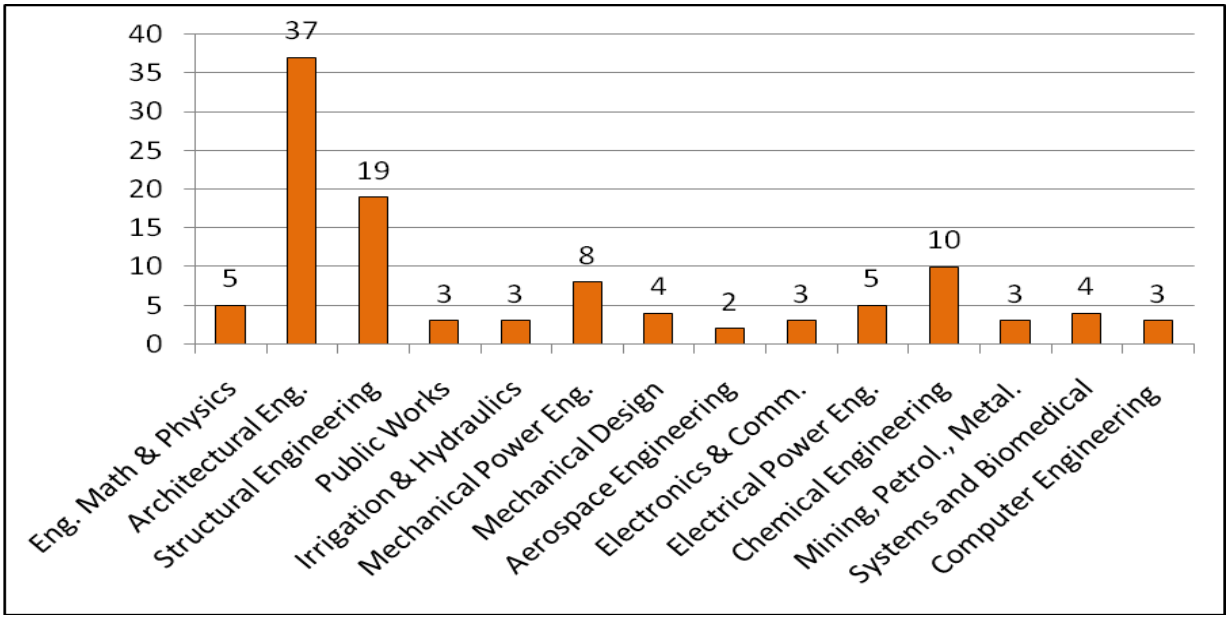

Figure 3: Numbers of Ph.D. degrees awarded in the various departments in 2018

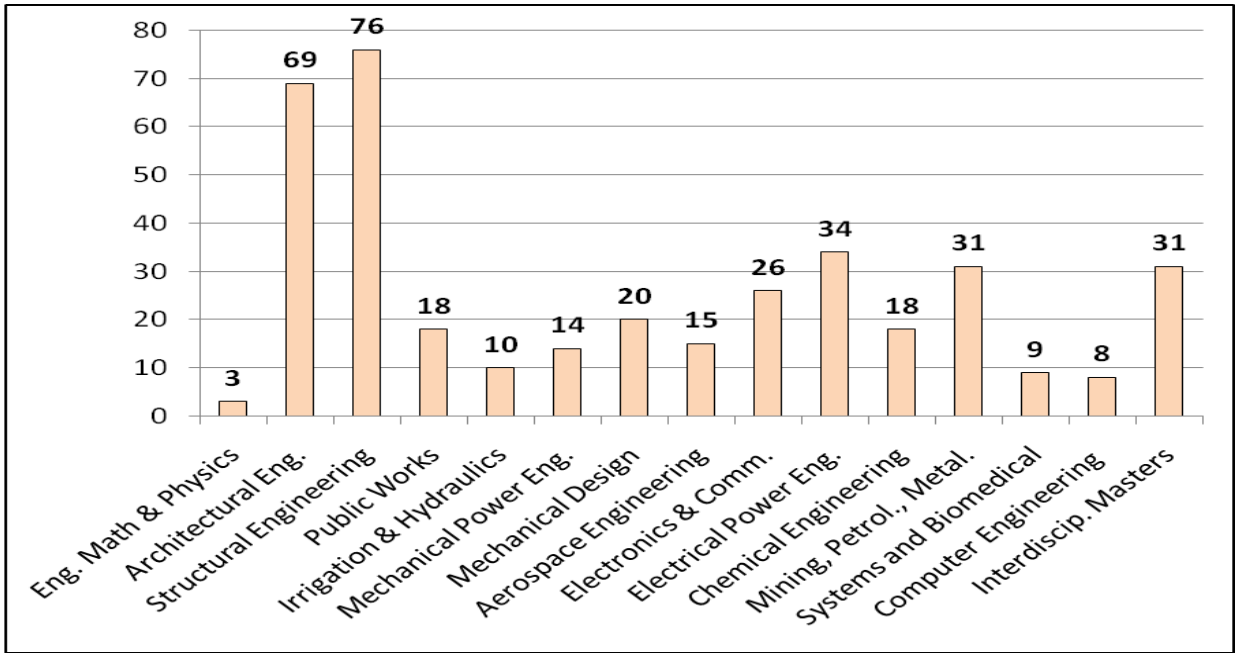

Figure 4: Numbers of M.Sc. degrees awarded in the various departments in 2018

3-2 Published Research

In addition to supervising graduation projects and scientific theses, CUFE faculty publish research papers in internationally acclaimed periodicals and scientific journals. The number of published papers in international journals has increased over the past two years to reach about 240 papers per year with a significant increase in the total impact factor to reach about 580.4.

Table 8 classifies the international publications of CUFE faculty by number and impact factor. The table also shows the contribution of CUFE international publications to the total publications of the other faculties of Cairo University during the period from 2013 to 2017. Figure 5 depicts the distribution of publications in 2017 among the different departments.

Table 8: Statistics on International Publications, 2013-2017

Year	No. of Papers	Percentage	Total Impact Factor	Percentage	Highest Impact Factor
2013	240	11.93%	239.07	8.58%	14.086
2014	167	10.82%	253.07	7.83%	14.464
2015	196	9.32%	247.07	6.07%	6.498
2016	246	11.5%	358.40	9.1%	9.446
2017	243	13%	580.40	12.1%	40.14

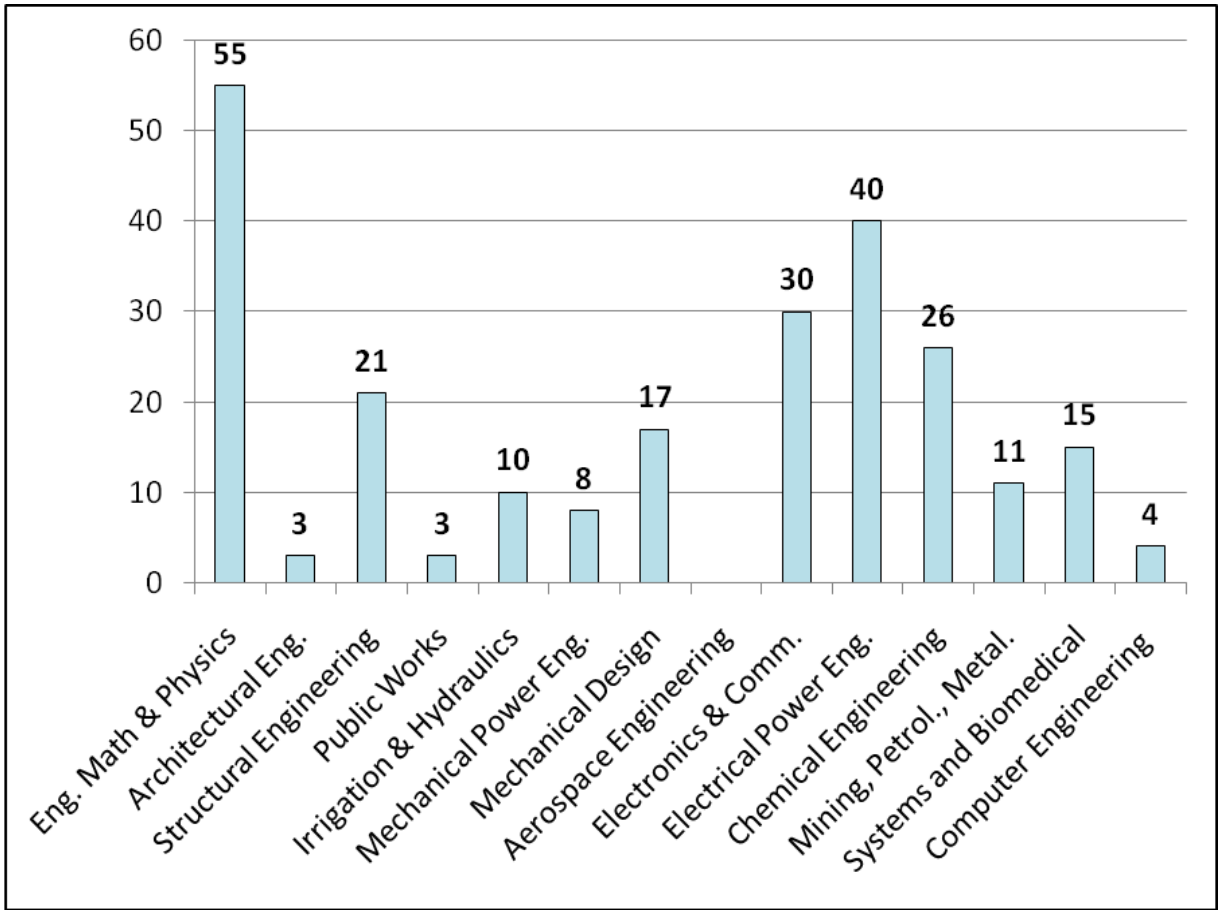

Figure 5: Distribution of publications in 2017 among the different departments

Research Plans of the Scientific Departments

1- Engineering Mathematics and Physics Department

Department Vision	The Engineering Mathematics and Physics Department aspires to be the best center in Egypt in interdisciplinary research in the fields of advanced applied mathematics, physics, and mechanics. Through research at the cutting edge of science and technology this will serve Egypt's strategic development plans in priority areas like energy, technology, communication, national security, education, agriculture technology and our environment.

Scientific Specializations	1	Engineering Mathematics
	2	Engineering Physics
	3	Engineering Mechanics

Research Fields for Each Specialization	1	**1- Engineering Mathematics** – **Computational Mathematics**: Applied mathematical research in areas of science and engineering where computing plays a central role. Computational mathematics research may include, but is not limited to, numerical methods, stochastic methods, operations research, optimization, nonlinear dynamics, fractional-calculus models, modeling and simulation. – **Computer Science**: Research in the theoretical foundations of information and computation as well as the development of models for computer-based systems. Computer science research may include, but is not limited to, artificial intelligence, machine learning, big data analytics, cybersecurity, data security and encryption, algorithms and software engineering.

Research Fields for Each Specialization	2	**2- Engineering Physics** – **Solid State Physics** – **Solid State Electronics** – **Solid State Electronic Devices:** This includes studying, analysis, modeling and designing novel device structures. This achieves better communication systems and enhanced energy harvesting methods. As a byproduct, this improves computational expertise. Thus research is directed towards examining solar cells, photonic crystals, carbon nanotubes, nanostructures, transistors, memristors, lasers and high speed photodetectors. Investigations also include terahertz radiation detection and its applications, which is considered a strategic technology. The latter field will provide non-invasive methods in medical imaging, industrial quality control, and security imaging for detection of concealed weapons. It also provides high speed telecommunications in the terahertz band. – **Infrared (IR) Thermography:** Research work on thermography involves acquisition enhancement and analysis of thermo grams. The results of such research are essential for many industrial and research applications in health, security and manufacturing. – **Physics of Applied and Computational Electromagnetics:** Research includes, but is not limited to studying, designing and modeling new Rectenna (Rectifying Antenna) structures. – **Biophysics:** Various research points are investigated; namely, modeling of the neuron and cancer growth, designing bio-materials and bio-implants, modeling and simulating biological processes, studying the effect of non-ionizing electromagnetic radiation on health and safety.

Research Fields for Each Specialization	2	– **Atomic and Molecular Physics and Molecular Spectroscopy:** Studies include, for example, molecular dynamics, examining the properties of molecular structures and clathrates. The latter would serve as a safe storage alternative for hydrogen gas and methane fuels.
	3	**3- Engineering Mechanics** – **Thermodynamics:** Through understanding and modeling thermal energy generation, storage, and transfer, we can find the optimal means to harness renewable sources of thermo-mechanical energy sources in wind systems and sea water for minimizing dependence on fossil energy. – **Geophysical Fluid Dynamics:** Through understanding, modeling and predicting of (i) surface and deep and coastal currents and (ii) wind-driven turbulent circulations in large seas, we can help protect coastal cities and tourist resorts from diffusion & dispersion of pollutants along shores and in river & lakes. Salination of agricultural adjacent land soils may also be minimized. – **Wave Mechanics:** Though studying the dynamical properties of water wave progressive motion, we can help protect the country Northern and Eastern shores and associated coastal cities from sediment accretion and from industrial & agricultural sources of pollution in their surrounding communities. – **Computational Hemodynamics:** Through understanding and computational modeling of the dynamical behavior of blood flows in arteries and veins, we can help enhance the consciousness level of preventive medicine from heart diseases.

Research Fields for Each Specialization	3	– **Solid Mechanics:** Through studying the behavior of different structures - e.g., dynamic behavior of beams, plates and shells resting on foundations - subject to dynamic loads, and studying the behavior of solid and fracture mechanics for linear and non-linear materials, we can help prolong their construction life time. Furthermore, these researches can help protect buildings and city structures during earthquakes or nearby explosions by devising protective codes and supportive building technologies.

2- Architectural Engineering Department

Department Vision	**To be a Pioneer in Architectural & Urban Education at both the Local & Regional Levels, & an active Participant in the International Architectural Movement.** Hence, the Mission of the Department is: - To prepare the Designing Architect & Creative Practitioner who is able to establish the interactive relations between Architectural Engineering & the continuously developing Society, who is capable of finding appropriate solutions for the local & regional needs and aspirations, who is trained to self develop and maintain professional ethics. - To Continuously Develop & Update the various aspects of the Educational Process including: Approaches, Definitions, Memorandums, Fields, Tools, Learning Environment & Staff Teaching Skills in order to maintain compatibility with the National & International continuous development - To Activate the Scientific Research so as to keep up with the local challenges and to interact with the global research trends & provide opportunities for interaction for students & graduates by supporting cooperation with local, regional & international educational, research & professional institutions

Scientific Specializations	1	Architectural Studies
	2	Building Science & Technology
	3	Environmental Design, Energy Efficiency & Renewable Energy in Buildings
	4	Urban Design & Community Development
	5	Urban Planning

Research Fields	1	**1- Architectural Studies** - Exploring the Latent Intellectual & Architectural Dimensions in the Traditional & Contemporary Theories inside or outside the Architectural Domain - Exploring the relation between Architectural Criticism & Contemporary Philosophical & Cultural Trends & its Applications in the Contemporary Architectural product in Egypt & its Regional context - The Mutual Relationship between Culture & Architecture, between Patterns & Spaces - Experimental Design: to focus on multiple and unconventional entries & tools for design - Digital & Virtual methods in Design & Realization of Space & Form
	2	**2- Compatible Technologies** - Philosophy of Construction Science & Sustainable Building Technology - Architectural Restoration - Project Management, Quality Control & Performance Improvement - Building Information Systems - Programming & Running Elements & Services - Value Engineering & Environmental Management & Economics - Projects Safety - Architectural Aerodynamics & Ventilation, Natural & Artificial Illumination, Architectural & Urban Acoustics - Environmental Simulation Systems for buildings and exterior spaces

Research Fields	3	**3- Environmental Sustainability** - Environmental Control Strategies & Energy Efficiency in Buildings - Architecture of Hot & Dry Regions - Low Carbon Emission Architectural & Urban Design - Renewable & Alternative Energy - Solar Energy in Architecture & Urban Design - Effect of Climatic Changes on City Planning - Communication & Sustainability Policies & Mechanisms in Desert & Coastal areas - Environmental Assessment Systems for Architecture & Urbanism - Energy & Resources Efficiency Assessment Systems in Architecture & Urbanism
	4	**4- Urban Studies** - Effect of Political changes on Urbanization - Urban Planning methods that are compatible with the desert & coastal Egyptian Environments - Urbanization & the management of Compatible Lands - Challenges of Contemporary Urbanism (Desert Urbanization, Unplanned Areas, etc …) - New Visions for Participatory Planning - Functional & Aesthetic Performance of the Urban Communities - Studying the Components & the Features of the Urban Character - Studying the Patterns of the Economic Development that are suitable to the Priorities of the Egyptian Regional Development - Architectural & Urban Conservation – Historic Areas Revivalism – Conservation & Preservation Economics

Research Fields	4	- Urban & Architectural Heritage Sites Management - Housing Policies Evaluation, Follow up & Reconciliation - Housing Limited Socio-economic Sector – Social Housing projects management – Informal Housing Areas Evaluation, Follow up & Development - Effectiveness of development Requirements & Control of urbanization in existing cities and new communities - Urban design for quality of life and preservation of resources - Sustainable Landscape Design

3- Structural Engineering Department

Department Vision	To conduct outstanding research in the field of Structural Engineering and Construction with profound recognition locally, regionally, and internationally, which tackles engineering problems in an innovative and sustainable approaches; with effective mutual coordination with international research authorities; and provide competitive graduates capable of dealing with research challenges and practicing engineering profession efficiently.

Scientific Specializations	1	Structural Analysis and Mechanics
	2	Properties and Strength of Materials
	3	Reinforced Concrete
	4	Metallic Structures and Bridges
	5	Construction Engineering and Management

Research Fields	- Linear and Non-Linear Analysis of the Behavior of Structures and Structural Members - Stability of Structures and Slender Structural Members - Solid and Computational Mechanics - Soil-Structure Interaction and Foundation Systems - Dynamic Analysis and Vibrations for Structural and Civil Systems - Modeling and Simulation of Structural and Civil Systems - Earthquake Engineering and Seismic Design - Analysis by Lateral Pushover and Evaluation of Seismic Performance - Techniques of Rehabilitation and Repair of Structures - Study of Fatigue in Metallic Members and Connections - Study, Evaluation and Enhancement of Specifications and Codes of Practice in the Field of Structural Engineering - Control of Dynamic Behavior of Structures - Computer-Aided Design

Research Fields	- Structural Analysis of Tanks and Silos - Utilization of Steel in Low Cost Buildings - Structural Analysis and Design of Straight and Skewed Bridges - Structural Analysis of Special Members such as Curved Beams, Plates and Shells - Plastic Analysis of Structural Members - Study of Structural Optimization for Buildings, Bridges, Towers, and Structural Members - Analysis and Design of Cable-Guyed Buildings, Roofs, Girders, and Towers - Analysis and Design of Buildings with Cold-Formed Steel Sections - Study of Structural Composite Sections and Connections - Supporting Structures and Tanks Using Fiber-Reinforced Polymers - Applications of Neural Networks in Structural Design - Modern Developments and Innovative Applications of Construction Materials in Green Structures - Adapted Technology of Alternative Construction Materials for Low Cost Housing - Applications of Composite, Smart & Green Construction Materials - Investigating Properties of Newly Introduced Types of Cement - Investigating possible Utilization of Chimney Dust of Cement Factories - Recycling of Construction Materials - Modern, Traditional and Non-Traditional Materials for Repair - Durability of Construction Materials in Different Exposure Conditions - Investigating Properties and local Production Methods for Special Types of Concrete - Investigating Properties of High Strength and Fiber Reinforced Concretes - Applications of Fracture Mechanics Theory on Concrete

Research Fields	- Behavior of Structures Subjected to Explosions - Behavior of Structures Subjected to Impact Loading - Investigating Progressive Collapse of Structures - Analysis and Behavior of Steel Connections - Fatigue of Steel and Metallic Members - Analysis of Steel Frames Under Seismic Loading - Stability of Steel Beams Under Various Loading Conditions - Analysis and Dynamic Control of Steel Structures - Optimization Analysis for Steel Structures - Stability and Dynamic Analysis of Metallic Plates - Seismic Analysis of Steel Bridges - Planning and Management of Construction Projects - Investment Analysis and Cost Evaluation of Construction Projects - Measuring Productivity and Performance Enhancement in Construction Sites and Construction Sector Companies - Cost Engineering and Quantitative Analysis Though Structure Life - Value Engineering - Contracts and Claims Management and Dispute Settlements - Infrastructure Assessment and Management Systems - Professional Health and Safety Management - Construction Methods and equipment - Simulation and Modeling Techniques of Construction Operations - Risk Management and Quantitative Modeling in Construction Projects - Decision Support Systems - Applications of Artificial Intelligence in Construction Engineering and Management - Information and Knowledge Management in Construction Operations - Building Information Modeling (BIM) - Sustainable and Green Infrastructure and Structural Systems

4- Public Works Department

Department Vision	To serve the community through quality education to provide the society with skilful civil engineers capable of supporting the development in Egypt and the Middle East with responsibilities including the planning, design, construction, maintenance, and operation of engineering projects.

Scientific Specializations	1	Geotechnical and Foundation Engineering
	2	Geomatics Engineering
	3	Highways, Airports, and Traffic Engineering
	4	Sanitary & Environmental Engineering
	5	Transport Planning & Traffic Engineering
	6	Railways Engineering

Research Fields for Each Specialization	1	**1- Geotechnical and Foundation Engineering** - Soil Behavior and Testing - Soil Dynamics & Geotechnical Earthquake Engineering - Soil Improvement for foundations and highway embankments - Earth Retaining Structures - Foundation Engineering - Geoenvironmental Engineering
	2	**2- Geomatics Engineering** - Vertical Datum Enhancement for Egypt with emphasis on Sea Level Rise. - Gravity Field Variation and Application from Global Satellite Missions-Geoid Determination for Egypt. - Global Navigation Satellite and Integrated Navigation Systems development. - Close Range Photogrammetry Applications.

Research Fields for Each Specialization	2	- Remote Sensing and LiDAR Data Applications. - Laser Scanning Applications.
	3	**3- Highways, Airports, and Traffic Engineering** - Traffic Engineering studies and research - Intelligent Transportation Systems - Traffic Safety and Highway accidents - Research on Highway Geometric Design - Highway Structural Design - Studies on Planning and Design of Airports - Research on Highway Economics - Research on Bituminous Materials
	4	**4- Sanitary & Environmental Engineering** - Research and development of Water and Wastewater treatment systems and using mathematical models for the prediction of their effluent quality. - Development and rehabilitation of Wastewater treatment plants using low cost systems. - Research and development of technologies for the reuse of treated wastewater and sludge. - Research and development of seawater and groundwater desalination systems. - Research and development of solid waste management and their recycling. - Modeling and analysis of different environmental systems and the assessment of their impacts. - Study of surface water pollutants migration and their effect on groundwater quality.

Research Fields for Each Specialization	5	**5- Transport Planning & Traffic Engineering** - Using mathematical models for transport demand prediction in Egyptian cities. - Developing engineering researches in traffic management and operation and its applications in Egyptian cities. - Studying and developing available methods to facilitate movement of transit in Egyptian cities. - Studying delays and its causes in highways and intersections inside cities. - Studying and deriving mathematical equations between traffic flow, speed, and density in Egyptian highways.
	6	**6- Railways Engineering** - Conducting research activities related to optimal utilization of the available resources at the Egyptian National Railways ENR facilities, which may include passenger coaches, locomotive, infrastructure, control system and many other assets. - Extend the research aiming to increase operation safety through deep investigation on accidents types and possible causes. The research activities will recommend solution to reduce number of accident in the railway sector. - Conducting research on optimal operation of trains along the network utilizing up to date tools. The research activities will consider possible obstacle on the lines that will cause delay. The research will aim to avoid any delay, increase level of service and level of safety while planning or operating train operations in Egyptian railways network. - Conduct research in the latest railway technologies in a goal to Increase network efficiency and railway network speed according to current global rates. - Conducting research on High Speed trains and its operation feasibility in Egypt.

5- Irrigation and Hydraulics Engineering Department

Department Vision	The Irrigation and Hydraulics Department seeks to alleviate the increasing pressure on the available national water resources through increasing the efficiency of water usage and to improve its quality by integrating the research activities of all the members of the department and directing them towards finding practical solutions to Egypt's water resources problems and the related environmental aspects at local and regional scales, which will help achieving the State's Sustainable Development Goals.

Scientific Specializations	1	Fluid Mechanics and Hydraulics
	2	Drainage and Irrigation Engineering
	3	Water Resource Engineering
	4	Harbor and Coastal Engineering and Inland Navigation
	5	Environmental Engineering and Renewable Energy
	6	Hydrology and Groundwater Engineering
	7	Water Resource Management

Research Fields for Each Specialization	1	**1- Fluid Mechanics and Hydraulics** - Flow in closed conduits, pipe lines, distribution and drainage networks. - Water Hammers and its protection works. - Turbulent flow application in pipelines and open channels. - Vortex movement and vorticity for different flow phases - Sediment transport characteristics (e.g., precipitation, volume, shape, distribution, etc..) at river beds and tanks under regular and extreme flow conditions (e.g., flooding). - Aeolian Sediment transport. - Derivation of numerical simulation models for different hydraulic applications.

Research Fields for Each Specialization	1	- Design of open channel cross-sections for irrigation and drainage networks and assessment of their flow characteristics.
		- River and flood hydraulics.
		- Sea water desalination studies
		  ○ Forward osmosis desalination studies
		  ○ Assessment of the impacts of intake and brine discharge points impacts on the marine environment.
		  ○ EIA of Northern and Eastern shores to identify sensitive zones and to develop an environmental shore maps.
		  ○ Hydraulically Optimum brine discharge techniques.
		- Design of hydraulic structures
		- Hydraulic performance of control and distribution gates.
		- Design of lifting stations and their control and protection

	2	**2- Drainage and Irrigation Engineering** - Design of highly efficient conventional and advanced irrigation networks (sprinkle-drip-subsurface). - Improving the efficiency of irrigation systems. - Studying the optimal cropping pattern/structure with lowest water demand and highest yield/productivity. - Evaluation and improvement of open drainage channels. - Evaluation and design of covered drainage networks. - Evaluation of main Nile hydraulic structures. - Treatment and reuse of agricultural drainage water. - Study of erosion around the hydraulic structure's foundation in waterways. - Water quality control in waterbodies due to sewage, agriculture and industrial wastes. - Optimum design of syphon's intakes and outfalls.

Research Fields for Each Specialization	3	**3- Water Resource Engineering** - Impact assessment; in terms of quality and quantity; of the water resources development projects in Upper Nile countries on Egypt's Nile water share. - Evaluation of the status of water resources related to national development mega projects (e.g., development of the Suez Canal zone; groundwater for one and half million feddans project) - Adaptation/development of non-conventional water resources(e.g., feasibility and economical study of agriculture wastewater reuse, evaluation of desalination techniques) - Development of an integrated simulation model for the Nile River system considering effects of climate change, hydrology and water resources development projects (locally and regionally). - Evaluation of Reservoir's operation system. - Virtual water analyses. - Conjunctive use of surface water and groundwater.
	4	**4- Harbor and Coastal Engineering and Inland Navigation** - Harbor management and Planning. - Design of breakwaters and harbor structures. - Design and management of coastal zones, shoreline stabilization, dredging and stabilization of artificial islands. - Impacts of erosion impact on the stability of breakwaters and platforms. - Design considerations for the impact of seismic forces on marine structures. - Developing Wave and Current Atlas for the Mediterranean and Red seas using calibrated numerical models.

Research Fields for Each Specialization	4	- Use of satellite data to assess and monitor the shoreline stability on the long term as well as the sediment transport, wave amplitude and sea bed bathymetry. - Sediment transport analysis in Harbor's navigation channels. - Environmental impact assessment of high salinity and treated wastewater effluent discharge on sea water quality. - Study of the mutual effect of marine structure, sea bed bathymetry and non-linear waves using numerical models. - Water quality analysis and water renewal rate inside ports.
	5	**5- Environmental Engineering and Renewable Energy** - Study of heat transfer budget and thermal stratification of lakes. - Study of wind effects on water stirring and internal wave generation. - Design of lakes' impinging jet mixers in lakers. - Design of fine Bubble lake aeration systems. - Sustainable water resources and solid waste managements. - Study of water movement in estuaries and straits between water bodies of different density. - Dynamic numerical modeling of climate and climate change at the regional scale, with emphasis on the impact on water resources. - Study of sea level rise and its impacts on coastal and delta areas. - Study of climate change impacts on surface water and groundwater resources. - Study the climate change effects on water usage for different development sectors, especially the agricultural sector. - Estimation and utilization of potential hydropower available in river basins.

Research Fields for Each Specialization	5	- Selection of optimal location for hydropower projects. - Determining the capacity of the hydropower plants and estimating their annual energy production.
	6	**6- Hydrology and Groundwater Engineering** - Hydrology of arid regions. - Soil-water-plant relationship. - Rain analysis using remote sensing. - Determining of rain-runoff-infiltration relationship. - Bio-hydro-geo-chemical analysis and solute reaction studies of the groundwater. - Solute transport studies in groundwater. - Study and classification of water catchments in arid regions at the national level using GIS and modern simulation models. - Flood protection and utilization studies. - Sustainable assessment of Egypt's main and secondary groundwater resources. - Identification groundwater pollution sources and the study of their mitigation and rehabilitation measures. - Sea-water intrusion and impact on groundwater reservoir. - Optimum use of high salinity aquifers and disposal of resulting brine. - Derivation of numerical models for flow and solute transport in fractured aquifers. - Use of Nanotechnology in groundwater pollutant removal.
	7	**7- Water Resource Management** - Environmental management of Water resources. - Water quality management of irrigation and drainage networks. - Integrated water resources management in Egypt.

Research Fields for Each Specialization	7	- Water budget variables and optimum use of Egypt's water share. - Egypt's water resources management strategy for the next 25 years. - Optimization of pumping/abstraction schemes from different reservoirs.

6- Mechanical Power Engineering Department

Department Vision	To provide top-quality, distinguished education both locally and internationally. To engage in society-related research, enhancement, and training activities which serve Egypt and the Arab World needs and to help in nation development and improving the quality of life. To provide a program graduate with both international scientific capacity and distinguished technical skills in the field of mechanical power engineering and energy efficiency. This graduate should also have a very high sense of belonging and dedication to Egypt and the Arab Nation.

Scientific Specializations	1	Heat Transfer
	2	Fluid Mechanics
	3	Combustion

Research Fields for Each Specialization	1	**1- Heat Transfer** - Study of energy in buildings - Study of parabolic Trough Concentrators using Nano Technology - Performance of multi stage desalination systems integrated with solar collectors. - Steam generation from boilers using thermal oil heated with solar collectors and comparison with conventional steam generation - Optimization of reverse osmosis water desalination systems - Energy efficiency in buildings and sustainable development - Development and conservation of energy use - Combustion in furnaces and combustion chambers in industrial boilers.

Research Fields for Each Specialization	1	- Mathematical modeling to control fire smoke in buildings and underground car parking. - Use of Solar energy in industrial process heating and cooling - Thermal energy storage system
	2	**2- Fluid Mechanics** **A. Fluid Mechanics** - Turbulent Flows and Applications - Two-Phase Flows and Applications - Unsteady Flows and Applications **B. Thermal and Hydraulic Turbomachines** - Flow Through Turbomachine Components - Testing and Prediction of Turbomachine Performance - Design Pumping Stations and Power Generation - Pipeline Networks and Internal Flows **C. New and Renewable Energy** - Wind Energy and Applications - Tidal Energy and Applications - Energy Storage - Environmental Energy and Pollution **D. Fluid Mechanics System** - Water Desalination - Industrial Ventilation - Automatic Hydraulic Control
	3	**3- Combustion** - Impact of design of internal combustion engines on performance and emissions - Hybrid Engines and impact on environment - Modeling of turbulent premixed combustion - Laser diagnostics of partially premixed flames

Research Fields for Each Specialization	3	- Combustion performance of bio-fuels - Design optimization of burner design for solid, liquid and gaseous fuels - Fire dynamics inside dwellings and industrial buildings - Fire hazards in oil fields and prevention techniques - Deflagration and Explosion in flammable gases networks, storage tanks and utilities.

7- Mechanical Design and Production Engineering Department

Department Vision	The goal is excellence and leadership in the teaching of mechanical design and production with focus on areas including design, manufacturing and industrial engineering. That role is to be performed locally, regionally and globally, leading to the provision of outstanding service to individuals, society and the environment. The department is interested in carrying out distinguished local, regional and international research, addressing engineering problems in innovative and sustainable ways in areas including mechanical design, production engineering and materials sciences, as well as industrial engineering. The department plays a leading role in the service and development of the Egyptian industry, where many of its members significantly contribute in various industrial fields. The department also conducts many training courses aimed at raising the efficiency of the engineers of industry in their fields of specialization. These activities are carried out directly with the department or through special units and centers in the faculty and the university.

Scientific Specializations	1	Machine Design
	2	Materials and Production Engineering
	3	Mechanical Vibrations and System Dynamics
	4	Solid Mechanics
	5	Industrial Engineering

Research Fields for Each Specialization	1	**1- Machine Design** - Nanomaterials and Machine Design. - Tribology.

Research Fields for Each Specialization	2	**2- Materials and Production Engineering** - Study of thermal stresses in different materials and composite materials. - Study of Nanotechnology Applications. - Study of manufacturing methods and improvement of production. - Applications of CNC in production and modernization of various machines. - Studying applications of ceramic materials. - Additive manufacturing. - Severe plastic deformation for producing nanostructured materials. - Materials simulation and modeling. - High temperature deformation mechanisms. - Light weight Al and Mg alloys.
	3	**3- Mechanical Vibrations and System Dynamics** - Acoustics and noise isolation. - Mobile robots. - Micro and nano robots. - Vibration analysis using finite element methods. - Flexible multibodies. - Rotor dynamics and magnetic bearings. - New and renewable energy (solar and wind). - Dynamics of composite structures. - Advanced Automotive Dynamics. - Fuzzy logic control. - New categories of control valves and positive displacement hydraulic pumps. - Water desalination. - Microfluids. - Control in Industry 4.0 systems.

Research Fields for Each Specialization	4	**4- Solid Mechanics** - Determination of loading limits in pressure vessels and compressed tubes in different cases of formal and surface defects arising from use conditions. - Determining the effect of the fracture in the forming processes. - Fatigue in welded carbon nanotube plates. - Study of fluid- structures interactions. - Applications of nanotechnologies.
	5	**5- Industrial Engineering** - Design and simulation of production systems. - Design and simulation of maintenance systems. - The use of expert systems and artificial intelligence and decision making in the planning and follow-up of production, risk analysis, and the identification of corrective and preventive measures. - The use of expert systems and artificial intelligence and decision making in the analysis of sources of risk and the identification of corrective and preventive measures. - Modeling and solving multi-layer inventory management problems (supply chains). - Ergonomic assessment and review of manufacturing systems.

8- Aerospace Engineering Department

Department Vision	The Department of Aerospace Engineering at Cairo University envisions the next 30 years working on aerospace and aeronautical multidisciplinary and environmental research projects supported by basic sciences and innovative aerodynamics, structures, propulsion and automatic control research lines to cope with the national executive strategic plan for science, technology 2030.

Scientific Specializations	1	Multidisciplinary
	2	Environmental
	3	Aerodynamics
	4	Structures
	5	Propulsion
	6	Automatic Control

Research Fields for Each Specialization	1	**1- Multidisciplinary** - Aircraft sizing and preliminary design for given mission - Design of micro UAV aircraft - Design of flying wing - Design of quad rotors - Analysis, design, manufacturing of micro and small satellites - Aerodynamic design, performance of wind turbine blades - Design and analysis of solar energy systems, - Wind tunnel testing to measure performance of vertical and horizontal wind turbines

Research Fields for Each Specialization	2	**2- Environmental** - Local and global environmental modeling - Computation and visualization of environmental parameters - Computation prediction of environmental changes - Noise computation - Biological fuel - Analysis, design of renewable energy control systems. - Water desalination using solar systems
	3	**3- Aerodynamics** - Computation of aerodynamic force on flying vehicles - Computation of performance and stability of flying vehicles - Simulation of aircraft motion response in accident situations - Aerodynamic design of turbine blades - Flight performance of helicopter
	4	**4- Structures** - Analysis, design of airframe, launchers, satellite structures - Analysis and design of high temperature alloys - Analysis and design of nonmaterial, composite structures - Applying smart materials to improve structure performance - Durability, reliability, integrity of space and airframes - Estimation of aerospace structure service life. - Measurements of mechanical vibration and audio vibrations - Signal analysis of sensors and sensor arrays - Mechanical system parameters recognition - Machine health monitoring

Research Fields for Each Specialization	4	- Aero elastic analysis of flying vehicles
	5	**5- Propulsion** - Numerical analysis of aircraft engine components - Design , analysis, of sprinkles in combustion engines - Numerical analysis of heat transfer in combustion engine - Numerical analysis of heat transfer in aircraft components - Analysis, design and performance of combustion chamber - Analysis of burning process performance in aircraft engines - Analysis of vaporization phenomena in aircraft engines - Burning in liquid fuel rocket engines - Burning in solid propellant in solid rocket engine - Numerical analysis for cracking of solid engine propellant. - Numerical analysis for burning alignment and burning performance in propulsion engines
	6	**6- Automatic Control** - Control systems for flying vehicles - Mechanics of flying vehicles - Managing of space projects and spacecraft mission analysis - Design, analysis, construction of airborne control systems - Design, analysis, construction of space control systems - Design , construction of consecutive control circuits - Design, construction of electro pneumatic control circuits. - Design of programmable control circuits - Applications of industrial control system - Analysis, design and manufacturing of under actuated aerospace systems

9- Electronics and Electrical Communications Engineering Department

Department Vision	We aim to provide an engineering educational environment that helps our graduates to gain high-quality engineering skills in the area of telecommunications and electronics, and to excel as responsible members of the society at the national and regional levels for the service of their country through a high sense of belonging

Scientific Specializations	1	Communications
	2	Electronics
	3	Electromagnetic Waves
	4	Computer Electronics and Communications
	5	Control

Research Fields for Each Specialization	1	**1- Communications** - Channel Coding - Cognitive Radio Systems - Communications and Information Security - Communications Quality and Reliability - Communications Software - Communications Switching and Routing - Communications Systems Integration and Modeling - Communication Theory - Digital Image Processing - Digital Signal Processing - High-Speed Networking - Information Infrastructure and Networking - Multimedia Communications - Network Operations and Management

Research Fields for Each Specialization	1	- Optical Networking - Pattern Recognition - Radio Communications - Tactical Communications and Operations - Transmission, Access, and Optical Systems - Free space optics (FSO) - Visible light communications (VLC) - Machine learning in communications - 5G communication systems - Wireless sensor networks - Internet of things - Cellular networks optimization - Mobile Communication Systems - Power Line Communications - Satellite and Space Communications
	2	**2- Electronics** - Analog Integrated Circuit Design - Digital Integrated Circuit Design - Microwave and RF Circuits and Systems - Biomedical Circuits and Systems - Nano-electronics and Applications - Computer-Aided Design (CAD) - Embedded Systems - Testing and Verification - Electronic Device Modeling and Characterization - Nonlinear Circuits and Systems - Circuits and Systems for Communications - Multimedia Systems and Applications - Neural Networks and Applications - Power Management and Energy Circuits and Systems - Sensors and Actuators

Research Fields for Each Specialization	3	**3- Electromagnetic Waves** - Antennas - Computer-Aided Design - Computational Electromagnetics, Metamaterial Media, and Transmission Lines. - Electromagnetic Measurements - Filters and Passive Components - HF-VHF-UHF Technology - Lasers and Photon Detection - Microwave Acoustics - Microwave and Millimeter-Wave Integrated Circuits - Microwave and Millimeter-Wave Packaging and Manufacturing - Microwave and Millimeter-Wave Solid State Devices - Microwave Ferrites and Ferroelectrics - Microwave Field Theory - Microwave High-Power Techniques - Microwave Imaging - Microwave Low-Noise Techniques - Microwave Measurements - Microwave Photonics - Microwave Superconductivity - Microwave Systems - Microwave Technology Business Issues - Plasma Waves - Propagation - Remote Sensing - RF Accelerators - RF MEMS - RF Nanotechnology - RFIC - RFID Technologies - Signal Generation and Frequency Conversion - Terahertz Technology and Applications

Research Fields for Each Specialization	3	- Wireless Communications Propagation
	4	**4- Computer Electronics and Communications** - Pattern Recognition Techniques and Machine Learning Application in Image and Speech Recognition - Optimized Neural Networks Architectures - Computer Architecture and Computer Arithmetic - Object Tracking Hardware - Software-Hardware Co-design for Embedded Systems and Embedded Processor Design - Optimized Embedded Protocol Stacks - Network Performance Analysis - Radio Resource Management in 4G/5G Systems - Internet Congestion Control and Routing - Protocols for Internet of Things Systems - Wireless Ad hoc and Sensor Networks - Software Defined Radio (SDR) and Software Defined Networks (SDN) - Network and System Security - Cryptographic and Watermarking Techniques
	5	**5- Control** - Adaptive Control Systems - Automotive Controls - Behavioral Systems and Control Theory - Computational Aspects of Control System Design - Digital Control Systems - Discrete Event Systems - Distributed Parameter Systems - Fuzzy Logic and Fuzzy Control Systems - Hybrid Systems - Industrial Process Control

Research Fields for Each Specialization	5	- Intelligent Control - Manufacturing Automation and Robotic Control - Nonlinear Systems and Controls - Optimal Control Systems - Optimization Techniques - Power Generation - Robotics - Smart Grids - Stochastic Control Systems - Systems Biology - System Identification and Adaptive Control - Systems with Uncertainty - Variable Structure and Sliding Mode Control

10- Electrical Power Engineering Department

Department Vision	Leadership and Excellence in scientific research in areas of electrical energy generation from traditional and renewable resources, transmission and utilization of electrical energy in industry, buildings, utilities, and energy conservation, to improve the standard of living and to advance scientific research locally and internationally.

Scientific Specializations	1	Electrical Machines
	2	Automatic Control
	3	High Voltage and Protection
	4	Power System
	5	Generation and Utilization of Electric Power and its Economics
	6	Power Electronics

Research Fields for Each Specialization	1	**1- Electrical Machines** Wind energy applications relevant to electric machines and drives - Electric vehicles applications with focus on motors, drives, batteries and controls - Industrial Motors - Inverters Applications in Industry - Solar pumping applications - Hybrid off-grid systems integrating PV-Diesel Generators-Biogas-Small Scale Wind - Motor systems optimizations for industrial applications - Energy Harvesting - Modern motors technology.
	2	**2- Automatic Control** Applications of classical and modern automatic control systems - control components - computer control systems in industry - SCADA systems in industry - Robotics -

Research Fields for Each Specialization	2	operation research and engineering management - Artificial intelligence.
	3	**3- High Voltage and Protection** Noise management in partial discharge testing of insulation - use of quantum mechanics to improve and detect dielectric properties - protection of installations from the electric field - improvement of digital protection in high voltage networks - transient phenomena in high voltage networks and electrical circuit breakers - nanotechnology in conductors and insulators - electrical and magnetic fields in industry - application of modern grounding methods in Power stations - Reducing the risk of electrical lightning on power plants - insulation coordination- Factors affecting loading of high voltage cables - Advanced measurement techniques in high voltage engineering using laser
	4	**4- Power System** Planning, design, and analysis of electric power systems of different types such as that having direct current lines, flexible alternating current transmission lines, and distributed generation of new and renewable source of energies as well as conventional sources - Operation and control of electric transmission and distribution networks as well as Tie lines and isolated grids - Smart grids - Load management and electric energy conservation - Electricity markets - Applications of artificial intelligence techniques for solving power system problems - Design and operation of AC and DC microgrids - Energy storage systems - Data centers - Study of integrating renewable energy resources and electric vehicles into the grids

Research Fields for Each Specialization	5	**5- Generation and Utilization of Electric Power and its Economics** Renewable Energy Systems design and Storage Systems (optimal sizing, modeling, grid connection, energy management, distributed generation, energy efficiency, and applications (pumping, transportation, traffic, etc) - Power Quality (assessment, effects, mitigation devices design and location, and applications in industrial and residential buildings) - Digital Relaying (Grid, TL, Distributors, Cables, Transformers, Generator, etc).
	6	**6- Power Electronics** Energy Harvesting - Characterization of SiC and GaN Power Devices - Magnetic components for power electronics applications - Power Electronics for Renewable Energy Conversion - Improvement of power quality - High frequency, high efficiency battery charger systems - Modeling and analysis of power electronics converters Power electronics applications in electric power systems.

11- Chemical Engineering Department

Department Vision	- Raising the research capabilities of young faculty to prepare them for undergraduate and graduate teaching. - Stressing the application facet of research proposed by the various groups in conformity to the National executive strategic science, technology, and innovation plan-2030 by structuring academic research to fulfill industrial and societal needs. - Coordination between available lab facilities in the department, within the faculty, and other universities and research centers thus conforming with the sixth direction of the first path of the National Strategic Plan.

Scientific Specializations	1	Process Systems Engineering
	2	Heat, Mass, and Momentum Transfer Engineering
	3	Industrial Inorganic Technology
	4	Industrial Organic Technologies
	5	Physical Chemistry, Thermodynamics and Electrochemistry
	6	Environmental and Energy Engineering

Research Fields for Each Specialization	1	**1- Process Systems Engineering** - Integration of separation processes - Heterogeneous catalysis - Modeling and control of coupled reaction-separation processes - Energy storage systems - Optimization of solvent circulation structures - Economics of pollution abatement schemes - Synthesis and optimization of crystallization schemes - Computer control applications

Research Fields for Each Specialization	1	- Heat exchange networks - Polymerization kinetics and modeling
	2	**2- Heat, Mass, and Momentum Transfer Engineering** - Evaporation - Water desalination - Membrane separation processes - Liquid – liquid extraction - Computational fluid mechanics - Rheology - Chromatographic separation
	3	**3- Industrial Inorganic Technology** - Equilibria and kinetics of solid state reactions - Low cement refractories - Composite materials - Non-Newtonian behavior of fluids and pastes - Special cements for encapsulating hazardous waste - Ceramic nanomaterials - Geopolymers - Complex fertilizers
	4	**4- Industrial Organic Technologies** - Polymer science and technology - Hydro treating processes - Spent lubricating oil reclamation - Polymer composites - Cryogenic processing of natural gas - Petrochemicals processing - Petroleum Processing

Research Fields for Each Specialization	5	**5- Physical Chemistry, Thermodynamics and Electrochemistry** - High temperature phase equilibria - Application of equations of state to vapour liquid equilibrium - Thermodynamic analysis of chemical processes - Ion exchange applications - Polymer physical chemistry - Batteries and fuel cells - Corrosion and corrosion control - Applications of electrochemical techniques in environmental control
	6	**6- Environmental and Energy Engineering** - Nuclear materials - Biochemical engineering - Solid state biological reactions - Environmentally sustainable technologies - Waste recycling - New uses of waste materials - Air pollution modeling - Renewable energy

12- Mining, Petroleum and Metallurgy Engineering Department

Mining Engineering Program

Department Vision	The scientific research plan of the department and its three divisions is consistent with the requirements of sustainable development and the needs of the Egyptian society in 2030 to contribute to the optimum utilization of natural resources of mining in the extraction and industrialization stages.

Scientific Specializations	1	Mining Engineering
	2	Mineral Processing
	3	Rock mechanics
	4	Engineering Geology and Applied Mineralogy
	5	Engineering Risks Analysis
	6	Integration with the Other Mining Divisions (Mining, Petroleum and Metallurgical Engineering)

Research Fields for Each Specialization	1	**1- Mining Engineering** - Mine/tunnel ventilation and environmental control - Modeling and Computer applications in mining engineering - Evaluation, design and production planning of ornamental stones.
	2	**2- Mineral Processing** - Mineral processing technology - Rheological properties of minerals slurries - Crushing and grinding of rocks and minerals - Interfacial chemistry applications - Industrial minerals upgrading for different applications - Fine particle/powder technology

Research Fields for Each Specialization	2	- Mineral, building materials, and ornamental stone recycling and Waste management
	3	**3- Rock Mechanics** - Rock testing and Site selection - Drilling and blasting - Applications to cultural heritage - Non-Destructive Assessment of Stone Historical Structures
	4	**4- Engineering Geology and Applied Mineralogy** - Coal and Ornamental stones - Clay minerals - Geothermal Energy
	5	**5- Engineering Risks Analysis** - Mineral processing and Environmental hazards of minerals disposal and their wastes
	6	**6- Integration with the Other Mining Divisions (Mining, Petroleum and Metallurgical Engineering)** - Solving the Problems of the Drilling Operations (Rock Mechanics, Drilling Mud). - Extractive mining industries (Iron, steel, titanium, chromium, manganese, etc.). - Cement Industry (Ores, Ferroalloys) - Environmental Studies in Mining Industries - Risk Assessment and Management in Mining Industries

Petroleum Engineering Program

Department Vision	The scientific research plan of the department and its three divisions is consistent with the requirements of sustainable development and the needs of the Egyptian society in 2030 to contribute to the optimum utilization of natural resources of mining in the extraction and industrialization stages.

Scientific Specializations	1	Drilling Engineering of Oil and Gas Wells
	2	Production Engineering Technologies of the Oil and Gas
	3	Oil and Gas Reservoirs Engineering
	4	Evaluation of Oil and Gas Formations
	5	Integration with the Other Mining Divisions (Mining, Petroleum and Metallurgical Engineering)

Research Fields for Each Specialization	1	**1- Drilling Engineering of Oil and Gas Wells** - Horizontal Drilling - Deep Water Drilling - Drilling at High Pressure and Temperatures - Risk Management in the Drilling Operations - Economics of Drilling Operations - Development of New Well Completion Strategies - Development of Geomechanics applications related to drilling operations - Applications of the Artificial Intelligent Techniques in the Drilling Operations
	2	**2- Production Engineering Technologies of the Oil and Gas** - Applications of the Artificial Intelligent Techniques in the Production Engineering Operations

Research Fields for Each Specialization	2	- Development of Geomechanics applications related to production operations - Enhancement in the Design, Performance and Troubleshooting of the Artificial Lift Techniques - Development of Techniques to Identify the Formation Damage and Perform Optimum Stimulation Operations - Optimization in the Design of the Oil and Gas Processing Operations - Risk Management in the Production Engineering Operations - Gas Processing Plant Controls and Automation. - Dynamic Simulation of Gas Processing Plants. - Modeling for Gas Processing Plant Optimization Purposes. - Environmental Management of Gas Processing and Use. - Modeling a Low – Pressure Gas pipeline Network. - Production Optimization Applied to A Complete Field Integrated Oil Production System, (FIOPS). - Development of an Expert System to Select the Appropriate Equipment for Produced Oil Field Water Treatment.
	3	**3- Oil and Gas Reservoirs Engineering** - Applications of the Nanotechnology to Improve the Oil Recovery from the Matured Oil Reservoirs - Applications of the Artificial Intelligent Techniques in the Reservoir Engineering. - Development of Techniques to Monitor and Improve the Production from the Unconventional Resources (Oil Shale, Gas Shale, Hydrate Formations, Tight Gas Reservoirs. etc.)

Research Fields for Each Specialization	3	- Applications of the Enhanced Oil Recovery (EOR) Technologies in the Matured Reservoirs - Development of Techniques to Monitor, Identify and Minimize the Water Cut from the Oil Reservoirs - Development of Techniques to have better Reservoir Characterization and Simulation - Development of Techniques to Predict the Reservoir Performance
	4	**4- Evaluation of Oil and Gas Formations** - Applications of the Artificial Intelligent Techniques in the Formation Evaluation. - Development Advanced Techniques for Formation Evaluation - Development of Advanced Formation Characterization Techniques for Naturally Fractured Reservoirs. - Development Advanced Techniques for Upscaling of Formation Properties
	5	**5- Integration with the Other Mining Divisions (Mining, Petroleum and Metallurgical Engineering)** - Purification of Water Tanks from the Oils. - Solving the Problems of the Drilling Operations (Rock Mechanics, Drilling Mud). - Solving the Problems of the Production Operations (Corrosion, Material Selection) - Environmental Studies in Mining Industries - Risk Assessment and Management in Mining Industries

Metallurgy Engineering Program

Department Vision	The scientific research plan of the department and its three divisions is consistent with the requirements of sustainable development and the needs of the Egyptian society in 2030 to contribute to the optimum utilization of natural resources of mining in the extraction and industrialization stages.

Scientific Specializations	1	Extractive Metallurgy (Extraction)
	2	Mechanical Metallurgy (Shaping)
	3	Physical Metallurgy (Treatment)
	4	New and Advanced Materials
	5	Integration with the Other Mining Divisions (Mining, Petroleum and Metallurgical Engineering)

Research Fields for Each Specialization	1	**1- Chemical Metallurgy (Extraction)** - Effect of metallurgical industries on environment and the global warming. - Extraction of Zinc from steel furnace dusts. - Measurements of flour emissions from Al-electrolysis cells. - Electrochemical deposition of nickel alloys for Hydrogen fuel cells.
	2	**2- Mechanical Metallurgy (Shaping)** - Development of new processing techniques for alloys and materials of improved properties: welding, rolling and casting parameters. - Improvement of cast properties using ultrasonic treatments. - Prediction of cast microstructure via thermal analysis.

Research Fields for Each Specialization	2	- Effect of welding conditions on duplex and superduplex stainless steel properties - Effect of welding conditions on martensitic steel (9 Cr, P91) - Friction stir welding of aluminum and its alloys.
	3	**3- Physical Metallurgy (Treatment)** - Study of the dynamic solidification processes on the Al-Si alloys - Studies on metal properties and alloy developments - Studies on metal matrix composite materials - Heat treatments of steels and nonferrous alloys - Studies on composite materials with nano-components - Effect of microstructure on the wear behavior of alloys
	4	**4- New and Advanced Materials** - Study and development of modern technologies for manufacturing advanced materials: e.g., thin film technologies. - Materials for energy applications: thermoelectric, magnetic, solar energy, etc. - Development of ferrite and rare-earth magnets - Preparation and characterization of the Nano material
	5	**5- Integration with the Other Mining Divisions (Mining, Petroleum and Metallurgical Engineering)** - Extractive mining industries (Iron, steel, titanium, chromium, manganese, etc.). - Cement Industry (Ores, Ferroalloys) - Solving the Problems of the Production Operations (Corrosion, Material Selection) - Environmental Studies in Mining Industries - Risk Assessment and Management in Mining Industries

13- Systems and Biomedical Engineering Department

Department Vision	The Department strives **to be the leading institution nationally and regionally in education, research, and development of biomedical engineering systems and technologies**. The Department seeks to realize this vision through: - graduating distinguished biomedical engineers capable of continuing education and competing in the market, - providing an effective education and research environment for the faculty, teaching and research assistants, and students, and - strengthening the relations between the Department and other healthcare entities in Egypt including the Ministry of Health and Population, university hospitals, government hospitals, private hospitals, as well as companies that develop, manufacture and market biomedical systems and equipment.

Scientific Specializations	1	Biomedical Signal Processing
	2	Biomedical Image Processing
	3	Medical Imaging
	4	Medical Equipment
	5	Clinical Engineering
	6	Biomedical Pattern Recognition
	7	Medical Informatics
	8	Biomedical Modeling
	9	Bioinformatics
	10	Biomechanics and Rehabilitation Engineering

Research Fields for Each Specialization	1	**1- Biomedical Signal Processing** - ECG and EEG Analysis - Sleep Analysis - Brain-Computer Interface - Biomedical Signal Compression - Nonlinear Dynamical Modeling - Real-time Biomedical Systems - Parallel Computing in Biomedical Applications - Compressed Sensing in Biomedical Applications - Embedded Systems in Biomedical Applications
	2	**2- Biomedical Image Processing** - Sensing, Representation, and Modeling - Image and Video Analysis and Segmentation - Synthesis, Rendering, and Visualization - Motion Estimation, Registration, and Fusion - Image and Video Perception and Quality Models - Interpretation and Understanding - Filtering and Multi-resolution Processing - Distortion Reduction and Image Enhancement - Image Compression
	3	**3- Medical Imaging** - Magnetic Resonance Imaging and Spectroscopy - X-ray and Computed Tomography Imaging - Nuclear Medicine Imaging - Multimodality Imaging - 3D Medical Image Reconstruction and Display - Ultrasound Digital Imaging - Radiation Treatment Planning - Functional Imaging - Medical Image Archiving and Exchange - Imaging-Guided Therapeutic Intervention

Research Fields for Each Specialization	4	**4- Medical Equipment** - Biomedical Electronics and Circuits - Biomedical Sensors - Diagnostic Medical Equipment - Therapeutic Medical Equipment - Embedded Biomedical Systems - Brain-Computer Interface
	5	**5- Clinical Engineering** - Biomedical Safety - RF-based Identification in Hospitals - Risk Analysis - Biomedical Ethics - Hospital Planning - Technology Management in Biomedical Applications - Human Factors Engineering
	6	**6- Biomedical Pattern Recognition** - Data Mining - Computer-Aided Diagnosis - Biometrics - Machine Learning - Artificial Neural Networks - Deep Learning - Generative Adversarial Networks
	7	**7- Medical Informatics** - Electronic Health - Mobile Health - Telemedicine - Multimodal Biomedical Data

Research Fields for Each Specialization	7	- Medical Image Archiving and Exchange - Hospital and Information Systems - Natural Language Processing - Big Data - Cloud Computing - Blockchains in Biomedical Applications
	8	**8- Biomedical Modeling** - Synthesis and Display of 3D Medical Images - Finite-Element Modeling - Finite-Difference Time-Domain Methods - Multi-Physics Modeling - Laser and Light-Matter Interaction - Biomedical Electromagnetism - Nonlinear Dynamical Modeling in Biomedical Applications - Cell phone effects on humans - Quantum Computing in Biomedical Applications - Virtual Medical Equipment - Medical Physics Modeling
	9	**9- Bioinformatics** - Bioinformatics Algorithms - Proteomics - Gene Regulatory Networks
	10	**10- Biomechanics and Rehabilitation Engineering** - Biomechanics - Rehabilitation Engineering

14- Computer Engineering Department

Vision	To be the driving force for international computer engineering departments with distinguished members and graduate

Disciplines	1	Computer Architecture and Microprocessors
	2	Software Engineering and Computer Languages
	3	Computer Networks
	4	Artificial and Machine Intelligence and Robotics
	5	Computer Vision and Image Processing and Remote Sensing
	6	Computer Systems Security and Data Encryption
	7	Database Systems and Information Technology
	8	Modeling Simulation and Testing of Computer Systems
	9	Design Automation for Computer Systems and Circuits
	10	Parallel and Distributed Computational Systems
	11	Computer Graphics and Multimedia
	12	Embedded and Real Computer Systems
	13	Manufacturing and Processing of Computers
	14	Operating Systems and Algorithms
	15	Distributed and Mobile Computations over Networks
	16	Blockchain
	17	Data Science and Analytics

Research Areas for Each Discipline	1	**1- Computer Architecture and Microprocessors** - Computer Architecture - Memory and Cache Architectures - On-Chip Interconnections - Multi-core and Multithreading - Processor Micro-architectures

<table>
<tr><td rowspan="3">Research Areas for Each Discipline</td><td>2</td><td>2- Software Engineering and Computer Languages
- Service oriented architecture SOA
- Optimization, Reliability and Adaptation
- Context-Aware Pervasive Computing
- Agent-oriented Software Abstractions</td></tr>
<tr><td>3</td><td>3- Computer Networks
- Network Operations and Management
- Network Architecture and Design
- Network Flows and Security
- Routing Algorithms
- Network Standards and Protocols
- Next Generation Internet
- Network Simulation and Emulation</td></tr>
<tr><td>4</td><td>4- Artificial and Machine Intelligence and Robotics
- Machine Learning
- Search Engines
- Cognitive Robotics
- Robotics & Automotive
- Human-Computer Interaction
- Video Mining
- Computational Finance
- Computer Vision
- Computational Intelligence.
- Self- Search techniques
- Bayesian Networks
- Natural Language Processing
- Avitars
- Reinforcement Learning
- Deep Learning
- Self-Driving Cars
- Humanoid Robots
- Wearable Robotics
- Machine Translation
- Speech Recognition and Understanding
- Knowledge Acquisition
- Agent Technology (Intelligent Agents)
- Genetics-based machine learning
- Neural Networks
- Pattern Classification</td></tr>
</table>

Research Areas for Each Discipline	5	**5- Computer Vision and Image Processing and Remote Sensing** - Hyper-Spectral Image Applications - Image Reconstruction - Terrain and Crop Analysis from Remote Sensing - Computer Vision Applications (Industrial - Intelligent Visual Surveillance - …)
	6	**6- Computer Systems Security and Data Encryption** - Encryption - Network Security - Authentication Mechanisms - Enterprise data security - IP protection - Privacy protection - Electronic Payment Systems - Electronic Voting Systems - Hardware Security Units
	7	**7- Database Systems and Information Technology** - Distributed Databases - Database Security
	8	**8- Modeling Simulation and Testing of Computer Systems** - Modeling and Simulation of Multi-core Architectures - Modeling and Simulation of DSP Architectures
	9	**9- Design Automation for Computer Systems and Circuits** - Double Patterning for Photolithography. - EDA tools for Automatic Routing and Placement. - Design for Manufacturing and for Yield tools. - Formal Verification Tools - Hardware synthesis Tools from High-level Languages

Research Areas for Each Discipline	10	**10- Parallel and Distributed Computational Systems** - Parallel and Distributed Architectures - Parallel and Distributed Models - Interconnection Networks - Cluster and Grid Computing - High Performance Computing - Reconfigurable Computing - Wireless/Sensor Networks and Pervasive Computing - Cloud Computing
	11	**11- Computer Graphics and Multimedia** - Shape Simplification - 3D Models Segmentation - Object Reconstruction - Cloth and Texture Simulation
	12	**12- Embedded and Real Time Computer Systems** - Specification and Design - Hardware/Software Co-design - Static and Dynamic Timing Analysis - Modeling for Power, Performance and Reliability - Design Space Exploration - System on Chips - Validation, Verification and Debugging techniques
	13	**13- Manufacturing and Processing of Computers** - Multi-core Architectures and Supporting compilers and Operating Systems - Testing, Validation and Verification of Hardware Design
	14	**14-Operating Systems and Algorithms** - Multi-Core Operating Systems Kernels

Research Areas for Each Discipline	14	- Distributed Storage Systems - Randomized Algorithms - Combinatorial Optimization and Approximation Algorithms - Testing and Verification of Algorithms
	15	**15- Distributed and Mobile Computations over Networks** - Wireless Networks and Protocols - Wireless Technology - Security, Trust and Privacy - Data Measurement and Analysis - Ad hoc Networks - Sensor Networks and Embedded Systems - Resource Management and Wireless QoS - Mobile Internet - Mobile Computing
	16	**16- Blockchain** - Blockchain and Machine Learning - Blockchain Scalability and Performance - Blockchain Challenges and Mitigation Techniques - Blockchain Adaptability for IoT - Blockchain Applications in Energy and Healthcare
	17	**17-Data Science and Analytics** - Data Science - Analysis of Social Media - Semantic Web - Web Science - Social Computing - Data Driven Medicine - Privacy Enhancing Technologies for Data Science