

**The Faculty of Engineering offers (4) postgraduate programmes: list the programmes:**

**Academic Programmes:**

Master of Science (M.Sc.), Renewable Energy Engineering, Dual degree

**Professional Programmes:**

Master of Engineering (M.Eng.), Renewable Energy Engineering, Dual degree.

**Name of the Programme:**

**Renewable Energy Engineering:**

Bachelor's degree required for each programme / Required overall grade or GPA.

**Overall grade:**

M.Sc.: Grade of "C" (Good) or Post Graduate Diploma from Faculty of Engineering if the Graduate grade is lower than "C".

M.Eng.: Grade of "D" (Pass).

GPA to graduate is 2.70 (B-)

Total number of credits for the programme is 40 credits

**Programme structure**

# Professional Information

## 1 Aims of the programme

The programme of Renewable Energy aims to develop a thorough knowledge of the viable renewable energy technologies, with special reference to the generation of electricity in Egypt through the following:

- Provides a firm technical background in the key renewable energy fields and creates a context for energy production and use.
- Provides experience in evaluating broader energy issues, in particular related to environmental impacts of energy use.
- Enables students to specialise in a particular technology or implementation aspect.
- Enables students to undertake a project related to the specialisation in industry, a research laboratory or at the university and during which the student can gain practical or research experience.

## Graduate attributes

The following are the aimed graduate attributes:

- a) Demonstrate knowledge of conceptual engineering issues, informed by the forefront of both the academic and professional elements of the renewable energy discipline that enables the student to evaluate critically current research and methodologies.
- b) Use the fundamental laws and basic theorems of topics related to energy harvesting and generation, conversion, storage and transportation; and embedding it with relevant knowledge in his professional practice.
- c) Show awareness of the contemporary research problems and Conduct research and development activities in the field of renewable energy showing originality in the application and integration of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in the discipline.
- d) Apply the basic principles and different methodologies of scientific research and analytical approaches and use its tools to design and conduct experiments as well as analyse and interpret data in the area of specialisation.
- e) Propose solutions to defined professional problems that could lead to making decisions to it in areas relevant to renewable energy; showing capacity in a proper range of specialized professional skills and ability to use appropriate technological means, examples: use numerical and experimental methods to design renewable energy harvesting and generation systems, study role of material from which these parts were made, suggest modified designs for applications that would allow the integration of renewable energy, identify reasons for system failures and suggest protection, or mitigation techniques, etc.
- f) Communicate with groups and effectively communicate and report results to scientific community and demonstrate ability to lead teams.
- g) Apply advanced science and engineering principles to renewable energy systems to analyse, develop and design systems, processes and techniques for conventional and advanced contemporary applications considering economic aspects, and utilizing available resources to maximize their benefit and keep resources maintained.
- h) Display awareness of his/her role in community development and environmental conservation in light of global and regional variations, reflecting the commitment to integrity, credibility and in accordance with the rules of the profession.
- i) Develop him/herself academically and professionally and carry out continuous education by engaging in self- and life- long learning.

## Career opportunities

The MEng programme provides better options for students with BSc degrees to develop their fundamental and conceptual knowledge and to be engaged in professional activities.

## 2 Intended Learning Outcomes (ILOs)

### A. Knowledge and Understanding:

On successful completion of this programme, students should be able to demonstrate a knowledge and understanding of:

- A1. The principles of a range of renewable energy systems for optimal energy conversion;
- A2. The characteristics of the various types of technologies and the associated processes of manufacturing such systems;
- A3. Ethical and societal responsibility of researchers with emphasis on environmental impacts of energy use, and options for reduction;

### 2.1 Skills and other attributes:

#### B. Subject-specific cognitive skills:

On successful completion of this programme, students should be able to:

- B1. Devise experimental and mathematical evidence to assess renewable energy resources at a specified location given appropriate data and to conduct development in the field;
- B2. Analyse data to obtain general performance predictions about various renewable energy system output, and decision making in different professional;
- B3. Evaluate information in a useful way to make decisions with support from data and ideas integrated from a wide range of sources, including risk analyses and assessments;

#### C. Subject-specific practical skills:

On successful completion of this programme, students should be able to:

- C1. Design a range of renewable energy systems for optimal energy conversion at a given location and for particular applications;
- C2. Manage a project and apply appropriate processes to analyse data and results based on technological considerations, as well as economic and planning aspects of renewable energy systems;
- C3. Use appropriate mathematical methods for modelling and analysing engineering problems relevant to renewable energy systems;
- C4. Search for and retrieve information, ideas and data from a variety of sources C5. Report results professionally and ethically;

#### D. Key/transferable skills:

On successful completion of this programme, students should be able to:

- D1. Collecting data from a range of sources and correlating findings with concepts from various multi-disciplinary areas to reach solutions for energy systems

design, development, and applications;

D2. Adopt and integrate scientific methods with engineering approach to reach open-ended solutions to problems related to renewable energy applications;

D3. Use evidence based methods in the solution of complex and unfamiliar problems, , work and lead a team in different professional contexts, time management skills and continuing self-learning;

D4. Work with limited, incomplete and/or contradictory information in the solution of unfamiliar problems, and monitor, plan and reflect upon personal, educational and career development;

D5. Communicate effectively orally, visually and in writing at an appropriate level.

### **3 Teaching, learning and assessment strategies to enable outcomes to be achieved and demonstrated:**

#### *3.1.1 Learning and Teaching Methods:*

ILOs are acquired continually throughout the programme from a combination of lectures, timetabled and ad hoc tutorials, problem-solving classes, laboratory exercises, coursework exercises and self-study of pre-delivered resources. All elements are developed and reinforced throughout the programme but particularly through project work.

Throughout the programme students are encouraged to undertake independent reading both to supplement and consolidate what is being taught and to broaden their individual knowledge and understanding of the subject.

#### *3.1.2 Assessments:*

ILOs are tested and assessed throughout the programme. The assessment is based, predominantly, on conventional written coursework assignments and unseen written examinations but includes group coursework exercises, viva-voce examinations on project work, written project reports and/or papers, project logbooks and oral and visual presentations. In addition, informal testing is undertaken in tutorials and seminars.

### **4 Admission Criteria**

To join this programme, the student should hold an undergraduate B.Sc. degree. Further details of the admission criteria are outlined in the internal postgraduate prospectus for the Faculty of Engineering, issued 2014-2015.

### **5 Academic standards**

#### **External references for standards (Benchmarks)**

The external references for standards considered in the development of this programme were the Academic Reference Standards (ARS) prepared by the engineering education sector of the supreme council of universities in Egypt and those of the Framework for Higher Education Qualifications in England, Wales and Northern Island (Qualification Descriptors), Aug 2008.

## 6 What makes the programme distinctive:

The BUE Master Degree in Renewable Energy is a programme designed to allow graduates to develop their knowledge of renewable and sustainable energy systems. The programme includes optional choice of subject matter whilst still allowing the possibility of some specialisation. The programme is intended to produce engineers who will be the designers and developers of the next generation of renewable and sustainable energy systems.

Teaching staff are active and involved in the Energy Research related topics, which includes the new established Centre of Energy at the BUE, which influences the delivery and assessment methods used.

The programme is distinctive through its partnership with London South Bank University, which is a British University fully accredited and recognised as Highly Trusted Sponsor by the UK Border Agency.

<http://www.study london.ac.uk/universities?qclid=CMqkkcv88MYCFa3MtAodEsQGwQ>

The programme is also distinguished by the university's nationally recognised activities in the area of research led by the Centre for Renewable Energy (CRE), which makes its teaching led and flavored by research.

## 7 Curriculum Structure and Contents

No. of credit hours for MEng program: 40 credit hrs.

16 Hrs. Compulsory

18 Hrs. Elective

6 Hrs. Research project

## 8 Progression criteria

Progression Criteria:

- To join this programme the student may be required to study up to 9 credit hours of subjects, at the 500 level which he/she did not study before, as per the recommendation of the programme director and the students' engineering background, with a grade point average not less than (C+).
- Alternatively, the student may join this programme if he/she holds a postgraduate diploma grade point average not less than (C+).
- To progress the student should complete a total number of 34 credit hours with a grade point average not less than (B). The studied subjects should be at the 600 level. After completing 34 credit hours of taught modules, the student should complete 6 credit hours for his research project work and report writing.

Research Project Requirements:

A research report (6 credit hours) is equivalent to a project showing the student's ability to investigate a point related more to industry or field studies following the basic steps of data collection, analysis and results discussion.

## 9 Coding System

#	Programme	Code
1	Renewable Energy Engineering	REN

الرمز	القسم أو الشعبة: برنامج بينى	مسلسل
متج	هندسة الطاقة المتجددة	1

## 10 Programme Description

The MEng. degree in Renewable Energy consists of 40 credit hours distributed over a minimum of two years as follows:

Mandatory modules	16 hrs	6 Modules	25 %
Elective modules	18 hrs	6 Modules	58.3 %
Research Project	6 hrs		16.7 %
Total	40 hrs	12 Modules	100

### 10.1 List of Compulsory Modules

Code No.	Module Title	No. of units	No. of hours / week			
			Lec.	Tut.	Total	
REN 601	Renewable energy sources and environmental issues	3	2	1	3	
REN 602	Solar energy systems and fundamentals	3	2	1	3	
REN 603	Wind energy systems and fundamentals	3	2	1	3	
REN 612	Advanced Design of Experiments	3	2	1	3	
REN 620	Fundamentals of Finite Element	2	2			
REN 621	Technical Writing	2	2			
	Total	16				

### 10.2 List of Elective Modules

Code No.	Module Title	No. of Credit hrs	No. of hours week		
			Lec	Total	
REN 604	Energy Conversion, Storage, and Recovery	3	3	3	
REN 605	Advanced Fluid Mechanics	3	3	3	
REN 606	Advanced Turbo-Machines	3	3	3	
REN 607	Advanced thermodynamics	3	3	3	
REN608	Advanced Heat transfer	3	3	3	
REN 609	Advanced Aerodynamics	3	3	3	
REN 610	Advanced Materials for Energy Applications	3	3	3	
REN 611	Advanced Mechanics of Materials	3	3	3	
REN 613	Advanced Finite Element Analysis	3	3	3	
REN 614	Computational fluid Dynamics (CFD)	3	3	3	
REN 615	Electronic devices for PV applications	3	3	3	
REN 616	Grid-connected PV systems	3	3	3	
REN 617	Special readings	3	3	3	
REN 622	Mechanical Systems in Wind Engineering	3	3	3	
REN 623	Control and Electrical Systems in Wind Engineering	3	3	3	
REN 624	Implementation of Wind Energy Systems	3	3	3	

### 10.3 List of Compulsory Elective Modules

REN	618	Research project	6		6	
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# Professional Information

## 1 Aims of the programme:

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- Provides a firm technical background in the key renewable energy fields and creates a context for energy production and use.
- Provides experience in evaluating broader energy issues, in particular related to environmental impacts of energy use.
- Enables students to specialise in a particular technology or implementation aspect.
- Enables students to undertake a project related to the specialisation in industry, a research laboratory or at the university and during which the student can gain practical or research experience.

## Graduate attributes

The following are the aimed graduate attributes:

- a) Demonstrate knowledge of conceptual engineering issues, informed by the forefront of both the academic and professional elements of the renewable energy discipline that enables the student to evaluate critically current research and methodologies.
- b) Use the fundamental laws and basic theorems of topics related to energy harvesting and generation, conversion, storage and transportation; and embedding it with relevant knowledge in his professional practice.
- c) Show awareness of the contemporary research problems and Conduct research and development activities in the field of renewable energy showing originality in the application and integration of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in the discipline.
- d) Apply the basic principles and different methodologies of scientific research and analytical approaches and use its tools to design and conduct experiments as well as analyse and interpret data in the area of specialisation.
- e) Propose solutions to defined professional problems that could lead to making decisions to it in areas relevant to renewable energy; showing capacity in a proper range of specialized professional skills and ability to use appropriate technological means, examples: use numerical and experimental methods to design renewable energy harvesting and generation systems, study role of material from which these parts were made, suggest modified designs for applications that would allow the integration of renewable energy, identify reasons for system failures and suggest protection, or mitigation techniques, etc.
- f) Communicate with groups and effectively communicate and report results to scientific community and demonstrate ability to lead teams.
- g) Apply advanced science and engineering principles to renewable energy systems to analyse, develop and design systems, processes and techniques for conventional and advanced contemporary applications considering economic aspects, and utilizing available resources to maximize their benefit and keep resources maintained.
- h) Display awareness of his/her role in community development and environmental conservation in light of global and regional variations, reflecting the commitment to integrity, credibility and in accordance with the rules of the profession.
- i) Develop him/herself academically and professionally and carry out continuous education by engaging in self- and life- long learning.

## **Career opportunities**

The MSc programme equips the graduates with skills required for a provisional researcher who is capable of following research and writing academic papers, including managerial and ethical skills.

## **2 Intended Learning Outcomes (ILOs)**

### **A. Knowledge and Understanding:**

On successful completion of this programme, students should be able to demonstrate a knowledge and understanding of:

- A1. The principles of a range of renewable energy systems for optimal energy conversion;
- A2. The characteristics of the various types of technologies and the associated processes of manufacturing such systems;
- A3. Ethical and societal responsibility of researchers with emphasis on environmental impacts of energy use, and options for reduction;

### **2.1 Skills and other attributes:**

#### **B. Subject-specific cognitive skills:**

On successful completion of this programme, students should be able to:

- B1. Devise experimental and mathematical evidence to assess renewable energy resources at a specified location given appropriate data and to conduct development in the field;
- B2. Analyse data to obtain general performance predictions about various renewable energy system output, and decision making in different professional;
- B3. Evaluate information in a useful way to make decisions with support from data and ideas integrated from a wide range of sources, including risk analyses and assessments;

#### **C. Subject-specific practical skills:**

On successful completion of this programme, students should be able to:

- C1. Design a range of renewable energy systems for optimal energy conversion at a given location and for particular applications;
- C2. Manage a project and apply appropriate processes to analyse data and results based on technological considerations, as well as economic and planning aspects of renewable energy systems;
- C3. Use appropriate mathematical methods for modelling and analysing engineering problems relevant to renewable energy systems;
- C4. Search for and retrieve information, ideas and data from a variety of sources
- C5. Report results professionally and ethically;

#### **D. Key/transferable skills:**

On successful completion of this programme, students should be able to:

- D1. Collecting data from a range of sources and correlating findings with concepts from various multi-disciplinary areas to reach solutions for energy systems design, development, and applicants;

- D2. Adopt and integrate scientific methods with engineering approach to reach open-ended solutions to problems related to renewable energy applications;
- D3. Use evidence based methods in the solution of complex and unfamiliar problems, work and lead a team in different professional contexts, time management skills and continuing self-learning;
- D4. Work with limited, incomplete and/or contradictory information in the solution of unfamiliar problems, and monitor, plan and reflect upon personal, educational and career development,
- D5. Communicate effectively orally, visually and in writing at an appropriate level.

### **3 Teaching, learning and assessment strategies to enable outcomes to be achieved and demonstrated:**

#### *3.1.1 Learning and Teaching Methods:*

ILOs are acquired continually throughout the programme from a combination of lectures, timetabled and ad hoc tutorials, problem-solving classes, laboratory exercises, coursework exercises and self-study of pre-delivered resources. All elements are developed and reinforced throughout the programme but particularly through project work.

Throughout the programme students are encouraged to undertake independent reading both to supplement and consolidate what is being taught and to broaden their individual knowledge and understanding of the subject.

#### *3.1.2 Assessments:*

ILOs are tested and assessed throughout the programme. The assessment is based, predominantly, on conventional written coursework assignments and unseen written examinations but includes group coursework exercises, viva-voce examinations on project work, written project reports and/or papers, project logbooks and oral and visual presentations. In addition, informal testing is undertaken in tutorials and seminars.

### **4 Admission Criteria**

To join this programme, the student should hold an undergraduate B.Sc. degree with a minimum grade of Good. Alternatively, the student may join the MSc. programme if he/she holds a postgraduate Diploma or MEng degree from an Egyptian University. Further details of the admission criteria are outlined in the internal postgraduate prospectus for the Faculty of Engineering, issued 2014-2015.

### **5 Academic Standards**

#### **External references for standards (Benchmarks)**

The external references for standards considered in the development of this programme were the Academic Reference Standards (ARS) prepared by the engineering education sector of the supreme council of universities in Egypt and those of the Framework for Higher Education Qualifications in England, Wales and Northern Island (Qualification Descriptors), Aug 2008.

## 7 Curriculum Structure and Contents

No. of credit hours for MSc program: 40 credit hrs.

16 Hrs. Compulsory

6 Hrs. Elective

18 Hrs. Thesis

## 8 Progression criteria

Progression Criteria:

- To join this programme the student may be required to study up to 9 credit hours of modules, at the 500 level which he/she did not study before, as per the recommendation of the programme director and the students' engineering background, with a grade point average not less than (C+).
- Alternatively, the student may join this programme if he/she holds a postgraduate diploma with a grade point average not less than (C+).
- To progress the student should complete a total number of 22 credit hours with a grade point average not less than (B), at the 600 level.
- After completing 22 credit hours of taught modules, the student should complete 18 credit hours for his research work and thesis writing.

Thesis Requirements:

An MSc thesis (18 credit hours) should reflect that the student is capable of collecting and integrating data from a number of sources relevant to the state of the art, followed by critical review of previous studies. Hence the student is expected to define and state the problem of investigation, deduce a plan of work for the thesis, defining and describing the methodology of research.

A written thesis is required which shows the basic elements of state of the art, methodology of research and results and discussion sections, in addition to a conclusion.

## 9 Coding System

#	Programme	Code
1	Renewable Energy Engineering	REN

الرمز	القسم أو الشعبة: برنامج بينى	مسلسل
متج	هندسة الطاقة المتجددة	1

## 10 Programme Description

The M.Sc. degree in renewable energy consists of total 40 credit hours distributed over a minimum of 2 years as follows:

Compulsory modules	16 hrs	6 modules	25 %
Elective modules	6 hrs	2 modules	25 %
Thesis	18 hrs		50 %
Total	40 hrs	8 modules	100 %

### 10.1 List of Compulsory Modules

Code No.	Module Title	No. of units	No. of hours / week		
			Lec.	Tut.	Total
REN 601	Renewable energy sources and environmental issues	3	2	1	3
REN 602	Solar energy systems and fundamentals	3	2	1	3
REN 603	Wind energy systems and fundamentals	3	2	1	3
REN612	Advanced Design of Experiments	3	2	1	3
REN 620	Fundamentals of Finite Element	2	2		
REN 621	Technical Writing	2	2		
	Total	16			

### 10.2 List of Elective Modules

Code No.	Module Title	No. of Credit hrs.	No. of hours week	
			Lec	Total
REN 604	Energy Conversion, Storage, and Recovery	3	3	3
REN 605	Advanced Fluid Mechanics	3	3	3
REN 606	Advanced Turbo-Machines	3	3	3
REN 607	Advanced thermodynamics	3	3	3
REN608	Advanced Heat transfer	3	3	3
REN 609	Advanced Aerodynamics	3	3	3
REN 610	Advanced Materials for Energy Applications	3	3	3
REN 611	Advanced Mechanics of Materials	3	3	3
REN 613	Advanced Finite Element Analysis	3	3	3
REN 614	Computational fluid Dynamics (CFD)	3	3	3
REN 615	Electronic devices for PV applications	3	3	3
REN 616	Grid-connected PV systems	3	3	3
REN 617	Special readings	3	3	3
REN 622	Mechanical Systems in Wind Engineering	3	3	3
REN 623	Control and Electrical Systems in Wind Engineering	3	3	3
REN 624	Implementation of Wind Energy Systems	3	3	3

### 10.3 List of Compulsory Modules

REN	619	Research Thesis	18		18
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**REN 501 Fluid Mechanics**

Fluid properties: density, specific gravity, specific weight, compressibility and surface tension and dynamic and kinematic viscosities of a fluid.  
Fluid statics: hydrostatic pressure, and different types of manometers; pressure forces on plane and curved surfaces.  
Fluid kinematics: lines of motion; streamlines and equi-potential lines; flow motion in rectilinear and curvilinear domains. Governing equations of motion: continuity, momentum, energy equations. Flow similarity and dimensional analysis. Incompressible inviscid versus viscous flows. Structure of boundary layer flows: Laminar, laminar-to-turbulent transition, and turbulent flows, Flow between parallel plates, flow in rectangular and circular ducts.

**REN 502 Thermodynamics**

Concept of energy, property tables and charts of pure substances, first and second laws of thermodynamics, reversible and irreversible processes, sources of irreversibility, entropy and principle of its increase for a process, Carnot principle for heat engines, performance of steam and gas power plants.

**REN 503 Heat and Mass Transfer**

Fundamentals of heat transfer by conduction, steady and unsteady, forced and natural convection, radiation. Mass transfer: fundamentals and operations. Boiling and evaporation. Analysis of industrial heat and mass transfer operations, equipment design. Temperature and heat flux measurement techniques.

**REN 601 Renewable energy sources and environmental issues**

Global energy usage and trends. Renewable Sources of Energy. Energy losses and optimization of performance. Solar energy, wind energy, wave energy, bio-mass energy, tidal energy, geothermal energy, agricultural and organic waste energy.  
Environmental impact from solar and wind energy systems. Biofuels versus fossil fuels. Industrial pollution and hazardous waste due to production, storage, transportation, and utilization of both types of fuels. Principles of pollution control and prevention. Introduction to environmental impact assessment. Environmental audits.

**REN 602 Solar energy systems and fundamentals**

Availability of Solar Energy, estimation of the incoming radiation, different applications of solar energy (such as: electricity, desalination, drying...etc.)  
Solar collectors: types, design criteria, performance calculations, maintenance and their economic impact. Solar energy plants design and performance. Storage systems.  
PV principles, types, design and optimization, solar cell materials, module design and testing, thin films, inverters, PV system design, optimization and maintenance.

**REN 603 Wind energy systems and fundamentals**

Introduction to wind energy, basic concepts and definitions. Availability of wind energy. Economics of wind energy. Estimation of wind energy. Site selection for wind energy. Wind energy equipment selection and specification. Design criteria. Design of wind energy plant components (rotor blades, gearbox, tower,). Performance evaluation for wind energy power plants. Aerodynamics of wind turbines, speed control, and frequency modulation. Computer applications.

**REN 620 Fundamentals of Finite Element Method**

Basic concepts and field equations of interest. Vibrational Formulation & Approximation, Finite Elements Analysis of One-Dimensional and Two-Dimensional Problems.

**REN 621 Research and Report Writing**

Research methods – writing techniques - general form of a research paper - general style; Title Page; Abstract; Introduction; Literature Review; Materials and Methods (Methodology); Results; Discussion; Conclusion, Recommendation and Future Work

**REN 612 Design of Experiments and Measuring Techniques**

Strategy of experimentation, simple comparative experiments, ANOVA, randomized complete block design (RCBD), factorial design, 2k factorial design, fractional factorial, fitting regression models, response surface methods, application of 3D measurements, techniques for measuring flow rate, temperature, pressure...etc.

**REN 604 Energy Conversion, Storage, and Recovery**

Energy classification from source to end use. Energy resources: conventional/non-conventional and renewable/non-renewable. Energy conversion systems: steam and gas turbine plants, combined systems, co-generation, nuclear power plants. Energy storage: mechanical, hydraulic, compressed air, thermal, and chemical approaches. Recovery of stored energy and exchangers. Waste heat recovery systems: recuperative and regenerative exchangers, fluidized beds, heat pumps.

**REN 605 Advanced Fluid Mechanics**

Governing equations of motion for a viscous fluid - The dimensionless Navier-Stokes equations - Approximate solutions of the Navier-Stokes equations - The laminar boundary layer and exact solution - for steady and unsteady flows in 2D motion - Transition and origin of turbulence - The turbulent boundary layers along flat plate - pipe and rectangular channel - Approximate solutions of the Navier-Stokes equations - Flow measurements and measuring techniques - Boundary layer control.

**REN 606 Advanced Turbomachines**

Thermo-fluid dynamics aspects of fluid flow, efficiencies of turbomachines. Two dimensional cascades: turbine and compressor cascade correlations and performance. Axial turbines (two-dimensional analysis), axial flow compressors and fans (two-dimensional analysis), centrifugal compressors and

fans, radial flow turbines, and preliminary design fundamentals of turbomachines and three-dimensional considerations. Turbomachinery testing and instrumentation; computational fluid dynamics; CFD Solutions for Turbomachinery Design.

**REN 607 Advanced thermodynamics**

Thermodynamic laws, enthalpy, entropy, temperature vs entropy diagrams. Equations of state, property relations, properties of homogeneous mixtures. Exergy analysis. Thermodynamics of irreversible processes. Optimization applied to power generation, refrigeration cycles, and thermodynamic design of system components. Fundamentals of statistical thermodynamics. Thermal design of equipment and systems. Numerical solutions techniques to thermodynamic problems.

**REN 608 Advanced Heat transfer**

Three-dimensional heat transfer. Analytical and numerical methods. Graphical methods. Transient heat transfers in multi-dimensions. Thermal radiation between black and nonblack surfaces. Thermal radiation between gases and enclosures. Combined convection and Radiation heat transfer. Condensation heat transfer phenomena. Boiling heat transfer. Heat pipes. Special topics assigned to students.

**REN 609 Advanced Aerodynamics**

Properties of gases versus altitude, Equations of motion for viscous fluids, - Boundary layer approximation, Flow instabilities and laminar-to-turbulent transition, Boundary layer concept and flow separation, Aerodynamic characteristics of bluff body, and airfoils, Aerodynamic forces and moments, Potential flow theory, Directional stability - Flow control- Wind tunnel testing and measuring techniques

**REN 610 Advanced Materials for Energy Applications**

Motivations for new materials for energy applications (higher efficiency, reduced costs – enhanced lifetimes – lighter weights – reduced emissions – improved transmission, distribution and storage). Advanced materials for fossil fuel power plants – advanced materials for gas turbines and wind turbines – carbon capture transport and storage materials – advanced materials for hydrogen storage and transportation materials – materials for photovoltaics – materials for solar cells – materials for fuel cells - improved life management and reliability of materials. The course will be supported by necessary background in respective areas to cover needed basics in materials related topics. Fundamentals of materials for fusion and fission power plants.

**REN 611 Advanced Mechanics of Materials**

Review of stress strain concepts and relations- transformations of stress and strain – plane stresses – applications of finite element method - yield criteria - applications on yield criteria.

**REN 613 Advanced Finite Element Analysis**

Finite element formulation of: Beams, Frames, and laminae, Layers of Composite Materials, Materials with Non-Linear Behavior, Plastic Deformation, Contact problems, and Dynamic Analysis

**REN 614 Advanced Computational Fluid Dynamics**

The syllabus will include the governing equations of fluid dynamics and presentation of forms particularly suitable to CFD: continuity, momentum and energy equations. Finite difference method: difference equations and stability analysis; finite volume method approach and stability. The course will include also instruction in the use of the commercial CFD package CFX, to construct models, solve the fluid flow fields and analyses the results. The analyses considered will include the entrance length problem for laminar and turbulent flows, turbulent flow through an abrupt enlargement, laminar flow through a nozzle and turbulent flow around a circular cylinder. Experimental studies of flows around objects will also be undertaken for comparison with the CFD predictions.

**REN 615 Electronic devices for PV applications**

Introduction to photovoltaics: what are solar cells, present and future global issues/drivers, commercialization/economic factors, basic components of PV systems, the solar spectrum: terrestrial and space spectra; air mass (AM0, M1.5), introduction to 1st, 2nd and 3rd generation photovoltaics. Semiconductor physics: semiconductor properties for PV, direct vs. indirect bandgaps, carrier recombination and generation mechanisms, carrier transport equations. pn homojunctions: photocurrent and spectral response, non-idealities and real p-n diodes under illumination. Solar cell parameters: efficiency calculations (EFF,  $V_{oc}$ ,  $J_{sc}$ , FF) for ideal cells, non-idealities: series resistance, shunt resistance, optical and electrical loss mechanisms, basics of solar cell device design, lateral and vertical design, optical versus electrical tradeoffs and optimization.

**REN 616 Grid connect PV solar systems**

Power conditioning and maximum power point tracking (MPPT) algorithms based on buck- and boost-converter topologies Maximum power point tracking (MPPT) algorithms, Inverter control topologies for standalone and grid-connected operation. Analysis of inverter at fundamental frequency and at switching frequency. Feasible operating region of inverter at different power factor values for grid connected systems, Stand-alone PV systems. Consumer applications, residential systems, PV water pumping, PV powered lighting, rural electrification, etc., Grid-connected (utility interactive) PV systems. Active power filtering with real power injection, Modeling and simulation of complete stand-alone and grid connected PV systems.

**REN 617 Special readings**

Prerequisite: departmental approval. Given when interest develops. Topics may include analysis and/or design of energy or mechanical systems of current interest to mechanical engineers.

**REN 622 Mechanical systems in wind engineering**

The goal of this course is to learn how to apply fundamental principles of fluid mechanics, materials and mechanical systems to design reliable wind turbine components. The focus will be on the fundamentals of horizontal-axis wind turbines (HAWT), including energy conversion; wind turbine aerodynamics; performance; materials and design of wind turbine components. Another area of focus will be the compliance to codes and standards in today's design.

**REN 623 Control and electrical systems in wind engineering**

The goal of this course is to learn how to design and apply different control schemes of wind turbines. Selection of generation and electrical power conditioning systems

will be addressed. Grid connectivity as well as storage systems for utility applications as well as stand- alone applications will be covered.

This module will also focus on faults finding and other maintenance practices for wind turbine control and electrical systems. Another topic of focus will be the compliance to codes and standards in today's control system design.

**REN 624 Implementation of Wind Energy Systems**

The course provides an overview on the implementación of wind power projects, including planning for wind energy, environmental impact, location and economic aspects, focusing on the South-Mediterranean installations. The wind source and the effects on the produced energy are taken in consideration, describing the theoretical limits, external factors and the influence of the site and of the environment. The course explores the available advanced components, technologies, tools, systems, techniques and theories in modeling a wind farm. Feasibility, design, operating principles, layouts and installations are considered. Financial aspects during the entire lifetime of a wind turbine or wind farm is analyzed to perform calculations for assessing wind farm projects and for calculating the cost of energy from wind.

**REN 618 Research Project**

To be proposed and approved by academic advisor.

**REN 619 Thesis**

To be proposed and approved by academic advisor.



## Contact information

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## For more information

1. Required documents: <https://www.bue.edu.eg/general-requirements>
2. English Level:  
[https://www.bue.edu.eg/uploads/editor/PG%20English%20Level\\_Web%20site.pdf](https://www.bue.edu.eg/uploads/editor/PG%20English%20Level_Web%20site.pdf)
3. PG Tuition Fees: <https://www.bue.edu.eg/tuition-feess>
4. PG Scholarship Scheme: <https://www.bue.edu.eg/postgraduate-scholarships>
5. Application link: <https://pgs.bue.edu.eg/registration/Default.aspx>