College of Engineering & Technology
Study Plan for Bachelor Degree
Renewable Energy Engineering

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Contents

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Renewable Energy Engineering

Vision:
Establishing an engineering academic department in a modern and strategic specialization with the aim to support the global trends to protect and preserve the environment by using clean, renewable and sustainable sources of energies. In addition to support the local economy by using alternative sources of energy that have high economic returns.

Mission:
Provide higher engineering education in the field of generation of renewable and sustainable energy from solar energy, wind energy, bio energy, gyo-thermal energy and tide wave energy. Graduate engineers are capable to develop and use modern technologies in renewable energy in order to replace fossil fuel. In addition to provide researchers to conduct high level research to follow the scientific and technological progress in this advance field of knowledge.

Objectives:
- Support the higher education with a modern and strategic specialization.
- Graduate engineers with high engineering and technological skills capable to work in the field of energy in general and in renewable energy specifically.
- Graduate an academic environment that encourage staff member to perform their teaching, education and research roles in order to fulfill the objectives of the department.
- Support scientific research and publication in the field of renewable energy.
- Provide consultancy and engineering services.
- Organize continuous education courses and training so as to keep in step with fast technological progress in renewable energy.
- Active participation and cooperation with local society in renewable energy.

Outcomes of the Academic Program:
- Graduate specialized engineers capable of:
- Use of basic sciences and engineering concepts to handle renewable energy systems.
- Multi-disciplinary team work in renewable energy projects.

- Proper understanding and implementation of engineering ethics.
- The use of communication skills (writing and speaking) to express personal thoughts and ideas in proper manner.
- Analysis engineering problems and collect data in order to develop and design engineering systems.
- Use of engineering skills in practical engineering applications in engineering projects.

Employment Opportunities:

- Government and private sectors related to energy and renewable energy fields.
- Industrial, Agriculture and services sectors.
- Research institutions and scientific societies.
- Local and international consultancy centers.
- Engineering and technological incubators and development centers.

Subjects Coding:

Each subject is given a code consists of seven digits as shown below:

College Code		Specialization Code		Subject Level	Knowledge Field	Subject No.
7	6	5	4	3	2	1
C		D		Y	F	N

College Code (C)	
Code	**College**
BA	Business & Administration
ET	Engineering & Technology
NH	Natural & Health Sciences
UR	University Requirements

Specialization Code (D)	
Code	**Specialization**
BS	Basic Sciences in the College
RE	Renewable Energy
DN	Electrical Distribution Network
CR	Control & Robotics

LS	Landscape Engineering

Study Plan:

A student is awarded Bachelor degree in Engineering after successfully passes (158) credit hours according to the regulations in Al-Zaytona University for Science and Technology. The credit hours are indicated in Table (1):

Table (1): Credit hours for university, college, and specialization requirements.

Type of Requirements	Compulsory		Elective		Total		Notes
	No. of hours	Percentage	No. of hours	Percentage	No. of hours	Percentage	
University	**17**	**%10.75**	**0**	**0**	**17**	**%10.75**	**Less than 20%**
College	**22**	**%13.92**	**0**	**0**	**22**	**%13.92**	**Less than 15%**
Specialization	**104**	**%65.82**	**12**	**%7.59**	**116**	**%73.42**	**More than 65%**
Free Subjects	**0**	**0**	**3**	**%1.9**	**3**	**%1.9**	**Less than 5%**
Total	**143**	**%90.5**	**15**	**%9.5**	**158**	**%100**	

Knowledge Fields:

Table (2) illustrates the distribution of the theoretical subjects according to the knowledge fields.

Table (2): Theoretical knowledge fields for Renewable Energy Engineering.

Knowledge Field		Subjects	Credit Hours
0	Supporting Subjects	General chemistry, General physics, Applied Engineering Math, Differential equations, Numerical Analysis, Statistics & probabilities, Modeling & Simulation.	30
1	Mechanical Engineering	Statics, Dynamics & Vibrations, Engineering materials.	9
2	Electrical Engineering	Electrical circuits, Electronics, Electrical machines, Power electronics.	15
3	Thermodynamic & Fluids	Fluid mechanics, Thermodynamics, Heat transfer.	9

4	Measurements & Control	Measuring instruments, Automatic control, Embedded systems.	9
5	Energy	Energy conversion & efficiency, Energy economy, Environment & energy, By-laws for energy administrations.	10
6	Solar Energy	Thermal solar energy technology, Photo-voltaic technology, Water distillation using solar energy.	9
7	Wind Energy	Wind energy technology, Wind mills technology	6
8	Other Renewable Energy	Gyo-thermal energy, Bio-energy, Hydraulic energy and waves energy.	6
9	Projects & Training	Graduation projects, Field training	4

Practical Fields: These cover the following subjects;
Fluids mechanics, Heat transfer, Electric circuits, Electrical machines, Measurements & control, Power electronics, Solar Energy, Wind energy.

1. **University Requirements:** This requirement is (17) credit hours as shown in Table (3).

Table (3): Compulsory university requirements.

Subject Code	Subject Name	No. of Hours			Prerequisite
		Th.	Pr.	Credit	
UR00101	Arabic language skills	3		3	
UR00111	English language skills(1)	3		3	
UR00112	English language skills(2)	3		3	English language skills(1)
UR00121	Culture & civilization	3		3	
UR00122	History of Palestine	3		3	
UR00131	Computer skills	1		1	
UR00141	Leadership & communication skills	1		1	

2. **College Requirements:** This requirement is (22) credit hours as shown in Table (4).

Table (4): Compulsory college requirements.

Subject Code	Subject Name	No. of Hours			Prerequisite
		Th.	Pr.	Credit	
ETBS101	Calculus(1)	3		3	
ETBS102	Calculus(2)	3		3	Calculus(1)
ETBS111	General physics(1)	3		3	
ETBS112	General physics(2)	3		3	General physics(1)
ETBS113	Physics Lab.		2	1	
ETBS131	Hand engineering drawing		3	1	

ETBS132	Engineering drawing by computer		2	1	Hand engineering drawing
ETBS141	Workshop(1)		3	1	Hand engineering drawing
ETBS142	Workshop(2)		3	1	Workshop(1)
ETBS251	Engineering programming	2	2	3	
ETBS261	Engineering ethics	1		1	
ETBS362	Scientific research & technical writing	1		1	Engineering ethics

3. Specialization Requirements: This requirement is (116) credit hours distributed as follows:

(a). Compulsory Specialization Requirements: This requirement is (104) credit hours, as shown in Table (5).

Table (5): Compulsory specialization requirements.

Subject Code	Subject Name	No. of Hours			Prerequisite
		Th.	Pr.	Credit	
ETBS201	Applied Engineering Math	3		3	Calculus(2)
ETBS202	General Chemistry	3		3	
ETBS203	Chemistry Lab.		2	1	General Chemistry(*)
ETBS204	Differential Equations for Engineers	3		3	Applied Engineering Math
ETRE211	Statics	3		3	Calculus(2)
ETRE212	Dynamics & Vibrations	3		3	Statics
ETRE221	Electric Circuits(1)	3		3	General Physics(2)
ETRE222	Electric Circuits(2)	3		3	Electric Circuits(1)
ETRE223	Electric Circuits Lab.		2	1	Electric Circuits(1)
ETRE224	Electronics	3		3	Electric Circuits(2)
ETRE231	Thermodynamics	3		3	Applied Engineering Math
ETBS301	Numerical Analysis for Engineers	3		3	Applied Engineering Math
ETBS302	Statistics & Probability for Engineers	3		3	Differential Equations for Eng.
ETRE311	Engineering Materials	3		3	Statics
ETDN311	Electric Machines	3		3	Electric Circuits(2)
ETDN312	Electric Machines Lab.		2	1	Electric Machines(*)
ETRE323	Power Electronics	3		3	Electronics
ETRE324	Power Electronics Lab.		2	1	Power Electronics(*)
ETRE331	Fluid Mechanics & Hydrology	3		3	Differential Equations for Eng.
ETRE332	Fluid Mechanics Lab.		2	1	Fluid Mechanics &

					Hydrology(*)
ETRE333	Heat Transfer	3		3	Calculus(2)
ETRE334	Heat Transfer Lab.		2	1	Heat Transfer
ETCR341	Measurements & Instrumentations	3		3	Electronics
ETRE351	Energy Conversion	3		3	Electric Machines
ETRE401	Modeling & Simulation	3		3	Numerical Analysis for Eng.
ETRE481	Introduction to Renewable Energy	3		3	Energy Conversion
ETCR441	Automatic Control	3		3	Measurements & Instrumentations
ETCR442	Measurement & Control Lab.		2	1	Automatic Control
ETCR323	Embedded Systems	3		3	Electronics
ETDN482	Energy Economics	3		3	Intr. to Renewable Energy
ETRE451	Environment & Energy Engineering	2		2	Thermodynamics
ETRE461	Thermal Solar Energy	3		3	Heat Transfer
ETRE462	Photo-Voltaic Systems	3		3	Thermal Solar Energy
ETRE482	Gyo-Thermal Systems	3		3	Energy Conversion
ETRE551	By-Laws for Energy	2		2	Energy Economics
ETRE563	Water Desalination by Solar Energy	3		3	Thermal Solar Energy
ETRE564	Solar Energy Lab.		2	1	Thermal Solar Energy
ETRE571	Wind Energy Systems	3		3	Dynamics & Vibrations
ETRE572	Wind Mills Technology	3		3	Wind Energy Systems
ETRE573	Wind Energy Lab.		2	1	Wind Energy Systems
ETRE591	Graduation Project(1)			1	Pass (110) Cr. Hrs.
ETRE592	Graduation Project(2)			3	Graduation Project(1)
ETRE593	Engineering Training			0	Pass (100) Cr. Hrs.

(*) or concurrent

(b). Elective Specialization Requirements: This requirement is (104) credit hours, as shown in Table (6).

Table (6): Elective specialization requirements.

Subject Code	Subject Name	No. of Hours			Prerequisite
		Th.	Pr.	Credit	
ETCR544	Real-Time Systems	3		3	Embedded Systems
ETRE552	Power Plants Engineering	3		3	Intr. to Renewable Energy
ETRE553	Energy Storage	3		3	Pass (100) Cr. Hrs.
ETDN571	Distribution Networks Design	3		3	Pass (100) Cr. Hrs.
ETRE582	Hydraulic & Waves Energy	3		3	Pass (100) Cr. Hrs.
ETRE583	Hybrid Power System Design	3		3	Pass (100) Cr. Hrs.
ETRE584	Bio-Energy Technology	3		3	
ETRE585	Special Topics in Renewable Energy	3		3	Pass (100) Cr. Hrs.

4. **Free Subjects:** This requirement is (3) credit hours chosen from other colleges in the university.

Advisory Study Plan for Renewable Energy Engineering

First Year							
First Semester				Second Semester			
Code	Subject Name	CrHr	Prerequisite	Code	Subject Name	CrHr	Prerequisite
UR00101	Arabic language skills	3		UR00122	History of Palestine	3	
UR00111	English language skills(1)	3		UR00112	English language skills(2)	3	English language skills(1)
ETBS101	Calculus(1)	3		ETBS102	Calculus(2)	3	Calculus(1)
ETBS111	General physics(1)	3		ETBS112	General physics(2)	3	General physics(1)
UR00131	Computer skills	1		ETBS113	Physics Lab.	1	General physics(1)
ETBS131	Hand Eng. Drawing	1		ETBS132	Eng. Drawing by Computer	1	Hand Eng. Drawing
ETBS141	Workshop(1)	1		ETBS142	Workshop(2)	1	Workshop(1)
Total		15		Total		15	

Second Year							
First Semester				Second Semester			
Code	Subject Name	CrHr	Prerequisite	Code	Subject Name	CrHr	Prerequisite
ETBS201	Applied Eng. Math	3	Calculus(2)	ETBS204	Differential Equations	3	
ETBS202	General Chemistry	3		ETRE224	Electronics	3	Electric Circuits(1)
ETRE221	Electric Circuits(1)	3	General Physics(2)	ETRE222	Electric Circuits(2)	3	Electric Circuits(1)
ETRE211	Statics	3		ETRE212	Dynamics & Vibrations	3	Statics
ETBS251	Engineering Programming	3	Computer Skills	ETRE231	Thermodynamics	3	Applied Eng. Math
ETBS203	Chemistry Lab.	1	General Chemistry	ETRE223	Electric Circuits Lab.	1	Electric Circuits(1)
				ETBS261	Eng. Ethics	1	English language skills(1)
Total		16		Total		17	

Third Year							
First Semester				Second Semester			
Code	Subject Name	CrHr	Prerequisite	Code	Subject Name	CrHr	Prerequisite
ETBS301	Numerical Analysis	3	Applied Eng. Math	ETBS302	Statistics & Probability	3	Differential Equations
ETRE311	Engineering Materials	3	Statics	ETRE323	Power Electronics	3	Electronics
ETRE331	Fluid Mechanics	3	Differential Equations	ETRE333	Heat Transfer	3	Applied Eng. Math
ETDN311	Electric Machines	3		ETRE351	Energy Conversion	3	Electric Machines
UR00121	Culture & Civilization	3	Electric Circuits(2)	ETCR341	Measurements & Instrumentations	3	Electronics
ETDN312	Electric Machine Lab.	1	Electric Machines(*)	ETRE324	Power Electronics Lab.	1	Power Electronics(*)
ETRE332	Fluid Mechanics Lab.	1	Fluid Mechanics(*)	ETRE334	Heat Transfer Lab.	1	Heat Transfer
Total		17		Total		17	

Fourth Year							
First Semester				Second Semester			
Code	Subject Name	CrHr	Prerequisite	Code	Subject Name	CrHr	Prerequisite
ETRE461	Thermal Solar Energy Systems	3	Heat Transfer	ETRE401	Modeling & Simulation	3	Numerical Analysis
ETRE481	Intr. to Renewable Energy	3	Energy Conversion	ETRE482	Gyo-Thermal Energy	3	Intr. to Renewable Energy
ETCR342	Automatic Control	3	Measurements & Instrumentations		Elective(1)	3	Pass (100) CrHr
ETDN481	Energy Economics	3	Energy Conversion	ETRE451	Environment & Energy Engineering	2	Thermodynamics
ETCR323	Embedded Systems	3	Electronics	ETRE462	Photo-Voltaic Systems	3	Thermal Solar Energy Systems
ETCR442	Measurements & Control Lab.	1	Automatic Control	ETRE464	Solar Energy Lab.	1	Thermal Solar Energy Systems
UR00362	Scientific Research & Technical Writing	1	Engineering Ethics	UR00141	Leadership & Communications Skills	1	English Language Skills(2)
Total		17		Total		16	

Fifth Year							
First Semester				Second Semester			
Code	Subject Name	CrHr	Prerequisite	Code	Subject Name	CrHr	Prerequisite
ETRE571	Wind Energy Systems	3	Dynamics & Vibrations	ETRE572	Wind Mills Technology	3	Wind Energy Systems
	Free Subject	3		ETRE563	Water Desalination by Solar Energy	3	Thermal Solar Energy Systems
	Elective(2)	3	Pass (100) CrHr		Elective(4)	3	Pass (100) CrHr
	Elective(3)	3	Pass (100) CrHr	ETRE592	Graduation Project(2)	3	Graduation Project(1)

ETRE551	By-Laws for Energy	2	Energy Economics	ETRE573	Wind Energy Lab.	1	Wind Energy Systems
ETRE591	Graduation Project(1)	1					
Total		15		Total		13	

Renewable Energy Engineering
Course Description

Subject	Description
Calculus(1) **ETBS101**	Review of functions: notation, operations, Limits and continuity, including trigonometric functions, Derivatives: rates of change and techniques of differentiation, including trig functions, Function composition, chain rule, and implicit differentiation, Applications of derivatives: related rates and optimization problems, Exponential and logarithmic functions — graphs, derivatives, and applications, Inverse trigonometric and hyperbolic functions — graphs, derivatives, and applications, improper integrals, Techniques of integration — integration by parts, integration by partial fractions.
Calculus(2) **ETBS102**	Sequences and series, power series, convergence theorems: integral, ratio, and alternating-series tests, Polar coordinates and functions, integration and differentiation of polar functions, Vectors in three-dimensional space, spherical and cylindrical coordinates, Vector valued functions, Partial derivatives, multiple integrals, Topics in vector calculus.
General Physics(1) **ETBS111**	Physics and measurement, Motion in one dimension, Vectors, Motion in two dimensions, Force and motion, Kinetic energy and work, Potential energy and conservation of energy, Linear momentum and collisions, Rotation, Rolling and angular momentum.
General Physics(2) **ETBS112**	Electric Fields, Gauss's Law, Electric Potential, Capacitance and Dielectrics, Current and Resistance, Direct Current Circuits,

	Magnetic Fields, Sources of the Magnetic Field, and Faraday's Law.
Physics Lab. ETBS113	Developing a good understanding of a few important concepts in Mechanical physics, Learning to apply these concepts to familiar and unfamiliar situations and Gaining the ability to reason qualitatively and quantitatively about Mechanics.
Hand Engineering Drawing ETBS131	Orthographic and Isometric projections; Sketching, sectioning, dimensioning and layering. Introduction to descriptive geometry, perspective drawing. Engineering applications**.**
Engineering Drawing by Computer ETBS132	The Use of AutoCAD software in Engineering drawing. Geometric constructions and layering. Plotting to scale, blocks and attributes,
Workshop(1) ETBS141	General safety, materials and their classifications, measuring devices and their accuracy. Practical exercises including fitting, forging, carpentry, casting, welding, mechanical saws, shearers, drills, lathes, milling machines, shapers and grinders.
Workshop(2) ETBS142	Electrical installations, electric motor maintenance and operation, simple electric circuits design and implementation, Use and training on CNC machines, Design and production of domestic and office items.
Engineering programming ETBS251	Introduction to the C and C++ programming languages, Types of data, constants, and variables, Operations, Mathematical and logical expressions. Topics include object-oriented programming, memory management, advantages of C and C++, optimization, and others. Students are given weekly coding assignments and a final project to hone their skills.
Engineering ethics ETBS261	Understand social values and local costumes, respect from personal and professional perspective, concept of honesty from general and engineering point of view, scheduling and accurate time keeping, good manners in discussions and debating, proper rules to contract drafting and implementation and engineering refereeing, proper financial documentation.
Scientific Research & Technical Writing ETBS362	Objectives and directions of scientific research, research problem identification, data and information collection, possible solutions, optimal solution, evaluation of results, writing technical reports, good command technical language, documentation.
Applied Engineering Math ETBS201	Infinite Series; Infinite series of constant terms, Convergence tests, Power series and radius of convergence, Taylor and Laurent series. Linear Algebra; Vector analysis in Cartesian coordinates; Curvilinear coordinates and transformations to Cartesian, Spherical, and Cylindrical coordinates; Matrices and linear equations; Matrices and Linear Operators; Determinants, Eigenvalues and eigenvectors.

	Complex Numbers and Complex Variable; Representation of complex numbers, DeMoivre's formula, Powers and roots of complex numbers, Functions of complex variable.
General Chemistry ETBS202	Stoichiometry of formulas and equations. Gases and the kinetic-molecular theory. Quantum theory and atomic structure. The components of matter. The major classes of chemical reactions (precipitation, acid-base, oxidation-reduction, and reversible reactions). Thermodynamics: energy flow and chemical change. Quantum theory and atomic structure. Electron configurations and chemical periodicity. Kinetics: rates and mechanisms of chemical reactions. Equilibrium: The extent of chemical reactions.
Chemistry Lab. ETBS203	Performing Chemical Experiments based on the general chemistry course.
Differential Equations for Engineers ETBS204	Ordinary differential equations' Sturm-Liouville theory, properties of Special Functions, Solution methods including Laplace transforms, Fourier series: eigenvalue problems and expansions in orthogonal functions. Partial differential equation: classification, separation of variables, solution by series and transform methods. Models in Applied Mathematics; Applications to illustrate typical problems and methods of applied mathematics in solid and fluid mechanics, fields of physics, deformation and vibration, wave phenomena, diffusion phenomena, heat conduction, chemical and nuclear reactors, and biological processes.
Numerical Analysis for Engineers ETBS301	Introduction into numerical analysis. Introduction and practice in programming of Matlab and Simulink. Representation of data and numerical errors. Numerical Methods for the solution of systems of linear algebraic and differential equations. Matrices and their properties. Classification of systems of linear algebraic equations. Matrix factorization. Gauss elimination algorithm. Cholesky algorithm. Iterative methods (Jacobi, Gauss-Seidel) and their convergence. Eigenvalues and eigenvectors. Euler and Runge-Kutta methods and their properties for solving ordinary differential equations.
Statistics & Probability for Engineers ETBS302	Probability, Discrete Distributions and their applications, Continuous Distributions and their applications, Estimation of parameters, Hypothesis testing, Regression, Quality control for engineers.
Statics ETRE211	Vector mechanics of forces and moments, free-body diagrams, couples, resultants, equilibrium of particles and rigid bodies in two and three dimensions, forces in trusses, frames, and machines, centroids, centers of mass, distributed forces, internal shear forces and bending moments in beams, shear force and bending moment diagrams, friction, area of moments of inertia.
Dynamics &	Kinematics and kinematics of particles, Newton's laws, planar

Vibrations ETRE212	kinematics and kinetics of a rigid bodies, free vibration of single degree of freedom systems, harmonic excitation, general force response.
Electric Circuits(1) ETRE221	Overview: SI units , voltage and current; Ohm's and Kirchhoff"s Laws, circuits with dependent sources; simple resistive circuits: series, parallel and delta to wye; Techniques of circuit analysis: nodal and mesh analyses, source transformation, Thevenin and Norton equivalents; Amplifiers; Inductance, capacitance and mutual inductance; Natural and step responses of RL and RC circuits; Natural and step response of series and parallel RLC circuits; Sinusoidal steady state analysis.
Electric Circuits(2) ETRE222	Calculating average and reactive power, power in parallel loads, maximum power transfer. Analysis of 3-phase circuits: calculating wattmeter readings in 3-phase circuits. Introduction to Laplace Transform: poles and zeros, initial- and final value theorems. The Laplace Transform in circuit analysis. Active filter circuits. Fourier series. The Fourier Transform. Two-port circuits.
Electric Circuits Lab. ETRE223	Resistive circuits, Potentiometers, Superposition, Thevenin's theorem and maximum power transfer, RLC current and voltage characteristics, Frequency response of RL, RC and RLC circuits, Series and parallel resonant circuits, Amplifiers.
Electronics ETRE224	Introduction to semiconductor electronic devices. Semiconductor p-n junction, the transistor. Analysis and synthesis of linear and nonlinear electronic circuits containing diodes and transistors. Elementary analog circuit analysis. Fundamentals of transistors and voltage amplification. Characterization of MOS transistors for circuit simulation. Common-source amplifiers, MOSFET source-follower buffer stage, differential amplifier stage, and MOSFET current sources. Operational amplifiers. Development of a Basic CMOS Operational amplifier.
Thermodynamics ETRE231	Introduction to thermodynamics concepts, properties of pure substances, first law of thermodynamics: analysis of closed systems, analysis of open systems under steady and unsteady conditions, second law of thermodynamics, entropy.
Engineering Materials ETRE311	Normal and shear stress and strain, deflection of axially loaded members, thermal stress, torsion of bars with circular sections, shear stress, angle of twist, power transmission, bending of beams, bending and shear stress, combined loadings, beam deflection, column buckling.
Power Electronics ETRE323	Power semiconductor devices: types, drive circuits, protection circuits and power loss calculations. AC-DC converters: uncontrolled, half-controlled and fully controlled single-phase and three-phase rectifiers. AC-AC converters: cyclo-converters. DC-AC inverters: single-phase and three-phase. DC-DC converters'

	topologies analysis and design: step-down, step-up, and step-down/up converters.
Power Electronics Lab. ETRE324	Single-phase fully-controlled bridge rectifier with static and rotating loads. Single-phase half-controlled bridge rectifier. Three-phase controlled bridge rectifier. Single-phase ac voltage controller. Frequency converter. Single-phase bridge inverter with static and rotating loads. Three-phase bridge inverter. Step-down and step-up converter.
Fluid Mechanics & Hydrology ETRE331	Physical properties of fluids and fundamental concepts in fluid mechanics, hydrostatics, conservation laws for mass, momentum and energy, flow similarity and dimensional analysis as applied to engineering problems in fluid mechanics, laminar and turbulent flow, engineering applications such as flow measurement flow in pipes and fluid forces on moving bodies.
Fluid Mechanics Lab. ETRE332	Measurement of thermal conductivity, forced convection heat transfer, measurement of specific heat ratio, flow through nozzles, losses in pipes and fittings, hydrostatic pressure, impact of water jet, flow visualizations, performance of hydraulic positive displacement pumps.
Heat Transfer ETRE333	Introductory course for Conduction, Convection and Radiation. In conduction, the course covers: steady state (1D and 2-D), Transient state. In convection, the course covers: Forced (external and internal), natural convection and heat exchangers. In radiation, the course covers: black body radiation, radiative properties, shape factors and gray surfaces radiation.
Heat Transfer Lab. ETRE334	Experiments on thermo-fluid systems including: pipe flows, flow meters, hydrostatic forces, pump performance, jet forces, thermal conductivity, heat transfer coefficients, heat exchanger performance, air-conditioning processes, refrigeration cycles, boiling and condensation, and steam devices.
Energy Conversion ETRE351	This course covers three aspects of energy: Energy resources, Energy Conversion, Development, and environment. Energy Sources: Fossil fuels including, petroleum, coal, oil shale and tar sand, natural gas and hydrogen power. Renewable energy sources including: solar, wind, biomass, hydroelectric and geothermal. Energy Conversion: Conversion of thermal energy into electrical power including thermoelectric converters and fuel cells, thermoelectric systems, electric generators and alternators. Development and environment: implications for sustainable development: Technical, economic, ethical and philosophical aspects of sustainable development, Environment and sustainable development at urban, national and international levels.
Measurements & Instrumentations	Measurement and errors. Units and standards. Analog meters. Potentiometers. DC and AC bridge instruments. Transformers.

ETCR341	Electronics measuring instruments. Oscilloscope. Frequency and phase measurements. Transducers
Automatic Control ETCR342	Introduction to Feedback System. Review of System Equations. Block Diagram and Signal Flow Graphs. Time Response of Systems and Closed Loop Performance. Routh's Stability Criterion. The Root Locus Method. Frequency-Methods. Compensation Techniques. Introduction to Sampled Control System.
Measurement & Control Lab. ETCR441	Open and Closed Loop System Servomechanism Principles. The Effect of Gain. Integral Control, Proportional Control. Derivative Control and Velocity Feedback on System Performance. Frequency Response Measurement
Modeling & Simulation ETRE401	Basic principles of modeling and simulation. Modeling techniques of system's Components. Simulation techniques of Systems. This course introduces simulation techniques related to thermal and electrical systems are introduced. Design tools such as such as Matlab and LabVIEW.
Embedded Systems Design ETCR323	Introduction to Microprocessors, microcomputers and microcontrollers. Architecture of single-chip microcomputers. Interfacing and programming of single-chip microcontrollers. Assembly language programming, C language programming. System design based on a single-chip. Introduction to wireless sensor networks. Engineering applications.
Introduction to Renewable Energy ETRE481	Introduction to the renewable energy sources, overview of the potential of the environmentally friendly use of regenerative energy sources. Primary components for the conversion of natural energy in form of solar radiation into useful forms of energy, such as heat, and electrical energy are discussed. The content comprises the natural energy forms, the systematization of energy conversion principles, solar radiation, solar energy, solar thermal and photovoltaic systems as well as the importance of wind and waterpower.
Energy Economics ETDN482	Economic operation and unit characteristics ; economic planning and evaluation of power systems operation and management, Application of Kelvin's law to power systems, Bulk fuel supply economics, economics of reliability and deregulation in power systems.
Environment & Energy Engineering ETRE451	Application of scientific and engineering principles to an understanding of environmental issues associated with human activity. Mass and energy transfer, environmental chemistry, water and air pollution, pollutant transport modeling, pollution management, and risk assessment, and global atmospheric change. Introduction to the physical, chemical, and biological systems relating to the quality of water, land and air environments. Topics relating energy to environmental engineering will be addressed,

	these topics include carbon production, heat and energy transfer and thermal pollution.
Thermal Solar Energy ETRE461	The course comprises principles and technologies of solar thermal energy. Students will acquire an overview of solar radiation, calculation of incident power on stationary and sun-tracking solar thermal collectors, and an overview of solar thermal technologies. The course will comprehend modeling the performance and the efficiency of solar thermal collectors including a synopsis of quality test methods of solar thermal collectors. Knowledge on design and sizing of solar thermal systems, especially solar water heating systems, will be obtained by students attending the course. Finally, the course will describe relevant engineering applications of solar thermal technologies such as solar space heating and cooling.
Photo-Voltaic Systems ETRE462	The characteristics of sunlight. Semiconductor and P-N junctions. The behavior of solar cells. Cell properties and design. PV cell interconnection and module fabrication. Stand-alone photovoltaic system components. Designing stand-alone photovoltaic systems. Specific purpose photovoltaic applications. Remote area supply systems. Grid-connected photovoltaic systems. Photovoltaic water pumping system components. PV water pumping system design.
Gyo-Thermal Systems ETRE482	Geothermal Systems: Geothermal Exploration Techniques, Drilling Techniques and Logging Methods, Reservoir Physics, Well Test Analysis, Monitoring & Forecasting, Direct and Indirect Use of Geothermal Resources, Visualization and Modeling Techniques, design, sizing, analysis and environmental impacts of geothermal systems (Geothermal Power Plants and its types and Heat pump systems. Hydropower systems: hydropower systems including pico, mini, small and large scale plants. General overview of types of hydropower plants, planning, assessment of hydropower resources, dam design, mechanical and electrical equipment, economic analysis of hydropower plant and the environmental impacts.
By-Laws for Energy ETRE551	Energy management principles; energy conservation; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques – conservation in energy intensive industries; integrated resource planning; demand-side management; cogeneration; total energy schemes; thermal insulation; energy storage; economic evaluation of conservation technologies; analysis of typical applications. Energy law and regulation in the Arab world and worldwide.
Water Desalination by Solar Energy ETRE563	Methods of water desalination and treatment, Properties of water and lotions, Design and maintenance of desalination systems and water treatment systems. Study of energy requirements, and economic requirements of the main processes in water desalination

	and treatment systems. The use of solar energy in water desalination and treatment.
Solar Energy Lab. ETRE564	Hands-on laboratory experiments in the area of sustainable energy. The fundamental principles required will be provided prior to laboratory experimentation. Topics covered include but are not limited to, solar-thermal energy and photovoltaics, energy storage in batteries and ultra-capacitors, wind energy, ethanol production from corn and sugar and bio-diesel extraction from algae.
Wind Energy Systems ETRE571	Introduction to energy generation from wind energy sources. Historical applications of wind energy. Wind energy systems. Physics of wind energy. Types of vertical and horizontal turbines. Aerodynamics of turbines. Large turbine farms. Commercial, economic and environmental impacts of wind energy..
Wind Mills Technology ETRE572	Basic characteristics of wind. Site characterization. Statistical methods of wind analysis. wind resources assessment. Fundamental principles of wind turbines; horizontal axis (HAWT) and vertical axis (VAWT). Aerodynamics, mechanical and electrical design aspects of HAWT and VAWT. Performance analysis of wind turbines. Wind machine technologies.
Wind Energy Lab. ETRE573	Experiments on wind power generation, fans, and methods of energy stored in the batteries, and the study of their outputs.
Graduation Project(1) ETRE591	The student will be allocated a project and a supervisor at the first week of the semester. The student studies and analyses the project and presents a suggestion to implement the project in graduation project (2).
Graduation Project(2) ETRE592	The student implement the project allocated by the department in view of the results from graduation project (1).
Engineering Training ETRE593	The student undergo field training for eight weeks after passing 90 credit hours. The training will be in approved industrial engineering sites. The training is supervised by a member of staff from the department. Periodic reports about the progress of the training. The student should submit final report and undergo final examination, The training should be in a complete semester without any courses.
Real-Time Systems ETCR544	Introduction to real-time computer control systems, Hard and soft real-time systems. Microcomputer interfacing, Discrete system analysis, Discrete transfer functions, z-transform. Controllers implemented in real-Time systems. Implementation of real-time algorithms. Implementation of the basic PID algorithm in real-time, Synchronization of the control loop, Timing Considerations in implementation of Control Loops. Real-time operating systems. Engineering applications.
Power Plants Engineering	It covers power cycle review, thermal power plant and power market. Power cycle review covers: Vapor-cycles, gas turbine-

ETRE552	cycles, and combined-cycles. Thermal power plant covers: components, selection and economics for Steam and gas turbine power plants which include: steam generators, condenser and condensate, feed-water heating systems which covers Fuel management and boiler automatic control systems, turbine plant, generator plant, turbine and generator control and protection systems, cooling water systems, steam and water cycle, power plant thermal performance and efficiency losses. power market covers: Alternative power generation technologies, electricity and gas networks and markets, climate change and energy markets.
Energy Storage ETRE553	Principles for energy storage, Types of batteries used in renewable energy systems, Fixed and mobile battery applications. Energy storing technologies with emphasis on electrical and thermal energies storage. Energy storage strategies for system optimization.
Bio-Energy Technology ETRE584	Chemistry & Biochemistry of biomass, Biodiesel, Bio-Methane, Bio-Ethanol & Bio-Hydrogen, Bio-Energy Systems, Direct Biomass Combustion & Co-firing Technologies, Gasification & Pyrolysis Technologies, Analysis and evaluation of the Biotechnologies and policies and future of Bio-fuels and Bio-Energy.
Hydraulic & Waves Energy ETRE582	Fluid flow laws, of fluid flow, Hydraulic and pneumatic systems, Installation, modeling, performance, functionality and applications of hydraulic and pneumatic components (valves, pumps, cylinders, control of linear and rotary motion), Introduction to hydraulic and pneumatic power generation systems, Power transfer and control. Performance improvement of hydraulic and pneumatic systems.
Hybrid Power System Design ETRE583	It focuses on the design of hybrid power systems consisting of solar energy, wind energy, and integration with traditional electric power systems, as well as the impact of renewable energy on overall efficiency and economics.
Special Topics in Renewable Energy ETRE585	Specialized topics, selected by the board of the department, covering new trends in renewable energy engineering.
Distribution Networks Design ETDN571	Review to basic design International standards and code of practice. Basic considerations and distribution systems layout. Distribution transformers: Types, connections, harmonics, and voltage regulation. Distribution equipment: Circuit breakers, Auto repeater closers, fuses,. Distribution substations: Layout, protection, grounding, Insulation coordination. Distribution line construction. Basic consideration of transmission systems.