

Number of units 6	T 4	Pr 2	Th 2	Number of weekly hours	Annual System 30 weeks	Al-Esra'a University College Department: Engineering of Refrigeration and Air Conditioning Technologies
				Renewable Energy	Fourth stage	
<u>Course Objective</u>						
Teaching the student, the resources of renewable energy.						

Week	Topic	Lab. Experiment Assignments	Notes
1	General introduction to RE - RE Resources and application - - RE and environmental problems (Acid rain, Ozone layer depletion, Global climate change, Nuclear hazards)	Experiments and practical reports about renewable energy and measuring devices.	
2	- The sun - Reckoning of time (the equation of time and longitude correction)		
3	- Solar angles (declination, hour angle, solar altitude angle, solar azimuth angle, Sunrise and sunset times and day length, incidence angle)		
4	- Extraterrestrial solar radiation, Atmospheric attenuation, Terrestrial irradiation, Total radiation on tilted surfaces.		
5	- SE collectors - Stationary collectors (Flat-Plate Collectors, Compound Parabolic Collectors, Evacuated Tube Collectors)		
6	- Sun-tracking concentrating collectors (Parabolic Trough Collectors, Fresnel collectors, Parabolic Dish Reflectors, Heliostat Field Collectors)		
7	- Solar water heating systems - Passive systems (Thermo siphon systems, Integrated collector storage)		
8	- Active systems (Direct Circulation Systems, Indirect Water Heating Systems, Pool Heating Systems)		
9	- Heat storage systems (Air System Thermal Storage, Liquid System Thermal Storage, and Thermal Analysis of Storage Systems).		

FOURTH STAGE

10	<ul style="list-style-type: none"> - Module and array design (module design, and array Design) - Differential temperature controller, Placement of Sensors 		
11	<ul style="list-style-type: none"> - Hot water demand - Practical considerations (pipes, supports, insulation, pumps, valves, and instrumentation). 		
12	<ul style="list-style-type: none"> - Solar Space Heating and Cooling - Calculation of heat load 		
13	<ul style="list-style-type: none"> - Solar space heating and cooling (Space heating and service hot water, Air systems, Water systems, Location of auxiliary heater, Heat pump systems) - Solar cooling (Adsorption units, Absorption units) - Solar cooling with absorption refrigeration 		
14	<ul style="list-style-type: none"> - Industrial Process Heat (Solar industrial air and water systems, Solar steam generation systems) - Chemistry Applications (Reforming of fuels, Fuel cells, Materials processing, Solar detoxification) 		
15	<ul style="list-style-type: none"> - Solar Dryers (Active Solar Energy Dryers, Passive Solar Energy Dryers) - Greenhouses and Greenhouse materials. 		
Half-year Break			
16	<ul style="list-style-type: none"> - Solar Desalination Systems, Desalination processes - Direct collection systems (Classification of Solar Distillation Systems, Performance of Solar Stills) 	Experiments and practical reports about renewable energy and measuring devices.	
17	<ul style="list-style-type: none"> - Solar cells, Structure of Photovoltaic PV System 		
18-19	<ul style="list-style-type: none"> - Design of PV system - Hybrid PV/T systems and applications 		
20	<ul style="list-style-type: none"> - Solar Thermal Power Systems (Parabolic trough collector systems, Power tower systems) 		
21	<ul style="list-style-type: none"> - Solar Thermal Power Systems (Dish systems, Solar ponds) 		
Wind Energy			
22	<ul style="list-style-type: none"> - Introduction to WE - Power available in the WE 		

FOURTH STAGE

	<ul style="list-style-type: none"> - Wind turbine WT power and torque - Classification of WTs (Horizontal axis WTs, Vertical axis WTs) - Characteristics of wind rotors - Aerodynamics of WTs (Airfoil, Aerodynamic theories) 		
23	<ul style="list-style-type: none"> - Rotor design - Rotor performance - Analysis of wind data 		
24	<ul style="list-style-type: none"> - Wind energy conversion systems - Wind electric generators (Tower, Rotor, Gear box, Power regulation, Safety brakes, Generator) - Wind farms, Offshore wind farms - Wind pumps - Wind water heater 		
25	<ul style="list-style-type: none"> - Performance of wind energy conversion system - Power curve of wind turbine - Capacity factor 		
Hydro Energy HE			
26	<ul style="list-style-type: none"> - Introduction, Water Cycle - Water Turbines 		
27	<ul style="list-style-type: none"> - Hydropower Plants (Run - of - River Power Plants, Storage Power Plants, Pumped - Storage Power Plants) - system design 		
Bio Energy BE			
28	<ul style="list-style-type: none"> - Introduction to BE (biomass, biogas, biofuel) - Biomass Heating (Wood as a Fuel, Fireplaces and Closed Wood burning Stoves, Wood Pellet Heating) - Biomass Heat and Power Plants 		
Geothermal Energy GE			
29	<ul style="list-style-type: none"> - Introduction to GE - Geothermal Plants (Geothermal Heat Plants, Geothermal Power Plants), Geothermal Heat pump 		
Tidal Energy TE and Wave Energy WE			
30	-Tidal Power Plants, Wave Power Plants		