Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Thermal Engineering**
Credit Hours	**3**
Theoretical Hours	**3**
Practical Hours	**0**

Brief Course Description:

- Properties of a pure substance, Work and Heat, First law of thermodynamics for closed and opened systems, Principle of heat transfer (conduction, convection, radiation, combined heat transfer mechanisms), Steady state conduction, Heat exchanger

Course Objectives:

1. To familiarize the student with basic concepts in thermodynamics and heat transfer and develop an intuitive grasp the subject matter
2. Develop an ability to apply these basic concepts to engineering design problems
3. To provide the student with necessary analytical skills to solve various engineering problems in the field of Thermal Science, such as Power Generation, Heating, and Air conditioning

Detailed Course Description:

Unit Number	Content	Time Needed
1.	Introduction to Thermodynamics	
2.	Properties of Pure Substances	
3.	First Law of Thermodynamics	
4.	Second Law of Thermodynamics	
5.	Conduction Heat Transfer	
6.	Convection Heat Transfer	
7.	Radiation Heat Transfer	
8.	Cooling of Electronic Equipment	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture

Text Books & References:

□ **References:**

1. Y.A. Cengel, Introduction to Thermodynamics and Heat Transfer, Irwin/McGraw- Hill, 1997.
2. Fundamentals of Thermodynamics, 6th Edition Richard E. Sonntag, Claus Borgnakke and Gordon J. Van Wylen John Wiley and Sons Inc., New York, NY, 2003
3. Fundamentals of Engineering Thermodynamics, M. J. Moran, H. N. Shapiro 5th Ed, John Wiley & Sons, Inc., 2004, ISBN: 0-471-27471-2.
4. J.B. Jones and G.A. Hawkins, Engineering Thermodynamics, Second Edition, John Wiley & Sons, 1986

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Thermal Engineering Lab**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**3**

Brief Course Description:

- Pressure – Temperature relation in the saturation region; Compressor cycles and analyses; Heat pump performance; Conduction heat transfer; Radiation heat transfer; and Heat exchanger performance

Course Objectives:

1. To study the relation between the Saturation Pressure- Saturation Temperature relation
2. To investigate the main factors affecting the heat pump performance
3. To study the performance of reciprocating air compressor

Detailed Course Description:

Unit Number	Content	Time Needed
1.	Saturation Pressure- Saturation Temperature relation (Marcel Boiler)	
2.	Heat losses in Heat pump condenser	
3.	Energy balance of Heat pump	
4.	Coefficient of performance of heat pump	
5.	Air compressor polytropic work	
6.	Isothermal efficiency of reciprocating air compressor	
7.	Volumetric efficiency of reciprocating air compressor	
8.	longitudinal Condition in simple bar	
9.	radial Condition in simple bar	
10.	Conduction in composite bar	
11.	Effect of insulation on conduction heat transfer	
12.	Forced convection heat transfer	
13.	performance of parallel and counter flow heat exchangers	
14.	performance of cross flow heat exchangers	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Laboratory

Text Books & References:

References:

1. Y.A. Cengel, Introduction to Thermodynamics and Heat Transfer, Irwin/McGraw- Hill, 1997.
2. Fundamentals of Thermodynamics, 6th Edition Richard E. Sonntag, Claus Borgnakke and Gordon J. Van Wylen John Wiley and Sons Inc., New York, NY, 2003
3. Fundamentals of Engineering Thermodynamics, M. J. Moran, H. N. Shapiro 5th Ed, John Wiley & Sons, Inc., 2004, ISBN: 0-471-27471-2.
4. J.B. Jones and G.A. Hawkins, Engineering Thermodynamics, Second Edition, John Wiley & Sons, 1986.
5. Lab. sheets

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Fluid Mechanics and Hydraulic Machines**
Credit Hours	**3**
Theoretical Hours	**3**
Practical Hours	**0**

Brief Course Description:

- Fluid properties, fluid static's, fluid motion, continuity equation, momentum principle, energy principle, Fluid flow in pipes, pipe friction, introduction to Pumps, Types ,Selection and application of pumps

Course Objectives:

1. Develop competence in use of conservation laws (mass, energy, momentum) for analysis, design, selection, and operation of flow measuring devices, of open and closed water and waste water conveyance systems, and of hydraulic machines (pumps, turbines)
2. Utilize methods for risk and reliability analysis along with engineering economics in selecting components and systems
3. Strengthen understanding of phenomena (e.g., cavitation, pressure/flow relations, losses), devices, components and systems with laboratory experiments and field trips
4. Improve communication skills through report writing
5. Development of dimensionally consistent equations. Competence with both SI and British Gravitational system of units.
6. Development of mass, momentum, and energy balances.
7. Application of conservation equations for pipe flow, pumping, and simple open channel flow applications

Detailed Course Description:

Unit Number	Content		Time Needed
1.	**Introduction**	▪ Introduction, Units of measurement, fluid physical properties, Density, specific weight, viscosity, surface tension, compressibility	
2.	**Hydrostatics**	▪ Fluid pressure, Pascal's law, Pressure variation in static fluid, pressure head, Gage and absolute pressure, Pressure measurements (barometer, Manometers, Piezometer, Bourdon tube, engineering applications of hydrostatics	
3.	**Equilibrium of Floating Bodies**	▪ Archimedes principle, Metacenter and metacentric height, condition of Equilibrium, Oscillation f floating body	
4.	**Fluid Flow Concept**	▪ Types of flow, Laminar and turbulent flow, uniform flow, steady and unsteady flow, incompressible and Compressible flow ▪ Fluid energy: internal energy, Kinetic energy, potential energy, pressure energy ▪ Fluid motion equations: Continuity, equation of motion for steady flow, Bennoulli equation and its applications ▪ Flow measurement: Flow through Orifice, venture, flow over notches, Pitot tube, rotameter, discharge coefficients	
5.	**Flow through pipes**	▪ Types of flow in pipes, Reynolds number, boundary layer and flow in pipe, loss head in pipes Darcy-Wies formula of head in pipe, relation between friction coefficient and Reynolds ▪ Friction loss in sudden contraction and expansion ▪ Friction loss in fittings and valves ▪ Velocity distributions in pipe flow	

6.	**Pumps**	▪ Types of Pumps, Principle of operation ▪ Pump power and efficiency ▪ Net positive section head ▪ Reciprocating pumps: Construction, reducing flow fluctuations ▪ Positive displacement pumps ▪ Gear and screw pumps ▪ Centrifugal pumps ▪ Pumps performance and characteristics curves ▪ Power and efficiency calculations ▪ Unit Seven: Compressors ▪ Types of Air compressors ▪ Reciprocating compressors ▪ Centrifugal compressors	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

❖ Lecture

Text Books & References:

1. Textbook of Hydraulics, Fluid Mechanics and Hydraulic Machines by R.S. Khurmi, Publisher: S Chand, New Delhi (May 1987), ISBN: 8121901626
2. Franzini, Fluid Mechanics with Engineering Applications, 10th Edition, McGraw Hill, 2002.
3. Giles R V et al, "Schaum's Outline of Theory and Problems of Fluid Mechanics and Hydraulics", 3rd Edition, McGraw-Hill, 1994.
4. E. John Finnemore and Joseph B Franzini, Fluid Mechanics With Engineering Applications, 10th Edition

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Fluid Mechanics and Hydraulic machine Lab.**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**3**

Brief Course Description:

- Measuring of physical properties of fluids, force on immersed plate, Jet force on plate, Bernoullis equation, Reynolds experiments, flow through orifices, and nozzle venture friction factor

Course Objectives:

At the completion of this course, each student is expected to be able to:

1. Validate Bernoullis equation
2. Measure the fluid Density and viscosity
3. Determine the Force of pressure on immersed plate
4. Study the Energy loss and friction coefficient
5. Perform Flow rate measurements (by orifice and venture)
6. Study the performance of Reciprocating, gear, and centrifugal pumps
7. Connect pumps in series and parallel and investigate the performance of each configuration

Detailed Course Description:

Unit Number	Content	Time Needed
1.	Density and viscosity measurements	
2.	Force of pressure on immersed plate	
3.	Demonstrating of Bernoullis equation	
4.	Flow rate measurements (flow through orifice and venture)	
5.	Energy loss and friction coefficient measurements	
6.	Head loss in smooth and rough pipes	
7.	Pipe flow, Reynolds number and laminar and turbulent flow in pipes	
8.	Flow over notches and Weirs	
9.	Pump Testing in Series-Parallel	
10.	Reciprocating pump performance	
11.	Gear pump efficiency	
12.	Performance of Reciprocation air compressor	
13.	Centrifugal Pump Testing	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Laboratory

Text Books & References:

References:

1. Textbook of Hydraulics, Fluid Mechanics and Hydraulic Machines by R.S. Khurmi, Publisher: S Chand, New Delhi (May 1987), ISBN: 8121901626
2. Franzini, Fluid Mechanics with Engineering Applications, 10th Edition, McGraw Hill, 2002.
3. Lab sheets

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Electricity and Electronics**
Credit Hours	**2**
Theoretical Hours	**2**
Practical Hours	**0**

Brief Course Description:

- Concepts and Definitions, Circuit elements, Circuit analysis, HVACR Controls and Circuits, Electronic devices, Diodes, Transistors, Rectifiers, Amplifiers, Logic gates and IC. Electrical protection and control devices in HVACR

Course Objectives:

Upon completion of this course, the student should be able to:

1. Distinguish between AC and DC electricity.
2. Determine voltage, amperage, and phasing of electrical supply sources:
3. Understand the Current and voltage measurement in electrical DC and AC circuits.
4. Apply Ohms and kerchiefs laws
5. Conduct Wiring and operating of electrical machines
6. Use control and protection devices applications in power electronics and logic circuits
7. Under stand and read the Air Conditioning and Heating electrical Circuits

Detailed Course Description:

Unit Number	Content		Time Needed
1.	**Fundamental Electricity**	▪ Magnetic theory ▪ Electrical Measurements **(**Meters**)** ▪ Electrical potential, current flow and resistance ▪ Electrical power ▪ Ohm's law ▪ Potential, current and resistance of an electrical circuit ▪ Electrical Safety	
2.	**Electrical Circuits**	▪ Ohms Law and the Electric Circuit ▪ Series Circuits ▪ Parallel and Series Parallel Circuits ▪ Circuit Analysis, Batteries and Electromotive Force ▪ Inductance and Capacitance ▪ Combination Circuits ▪ Transformers ▪ Power circuits in the air-conditioning industry ▪ Symbols and Diagrams for HVACR Systems	
3.	**Component, Symbols of Circuitry of HVAC Wiring Diagrams**	▪ Electrical loads are and their general purpose HVACR ▪ Common loads used in HVACR systems. ▪ Symbols of common loads used in HVACR systems. ▪ Relays and contactors in HVACR systems ▪ Symbols of relays and contactors HVACR systems ▪ Switches and the types used in HVACR systems ▪ Symbols of switches and the types used in HVACR systems	

		▪ Symbols and purpose of other miscellaneous controls HVACR systems ▪ Types of wiring diagrams used in the industry ▪ Simple schematic diagrams ▪ Advanced schematic diagrams ▪ Electrical Wiring Techniques ▪ Relays and thermostats	
4.	**Basic Electric Motors**	▪ Electrical loads are and their general purpose HVACR ▪ Common loads used in HVACR systems. ▪ Symbols of common loads used in HVACR systems. ▪ Relays and contactors in HVACR systems ▪ Symbols of relays and contactors HVACR systems ▪ Switches and the types used in HVACR systems ▪ Symbols of switches and the types used in HVACR systems ▪ Symbols and purpose of other miscellaneous controls HVACR systems ▪ Types of wiring diagrams used in the industry ▪ Simple schematic diagrams ▪ Advanced schematic diagrams ▪ Electrical Wiring Techniques ▪ Relays and thermostats	
5.	**HVACR Electricity**	▪ Electrical circuitry of: ▪ Freezer Circuits. ▪ Air Conditioning and Heating Controls and Circuits. ▪ Commercial Systems. ▪ Standing Pilot Furnaces.	

		▪ Electronic Ignition Gas-Fired Furnaces. ▪ Boilers. ▪ Oil Heat. ▪ Electric Heat. ▪ Ice Makers.	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

❖ Lecture

Text Books & References:

References:

1. ARI Edward F. Mahoney, Electricity, Electronics, and Wiring Diagrams for HVAC/R, 2nd Ed., , Publisher: Prentice Hall, 2006
2. Stephen L. Herman, Bennie Sparkman, "Electricity and Controls for HVAC/R, 5th Edition", ISBN 1-401-89513-1.
3. Russell E. Smith, Electricity for Refrigeration, Heating and Air Conditioning, 6th Edition, ISBN 0-766-87337-4
4. Thomas E. Kissell, Electricity, Electronics, and Control Systems for HVAC, 3rd Edition, ISBN 0-130-09662-8.
5. Edward F. Mahoney, Edward Mahoney Electricity for Air Conditioning and Refrigeration Technicians, 5th Edition, ISBN 0-130-10572-4
6. Textbook Required: Huran, Thomas F.; Electrical Fundamentals and Systems for HVAC/R, 2000 Prentice-Hall, Inc., 2000
7. Understanding Electricity and Wiring Diagrams for HVAC/R, Publisher: Prentice Hall, 2000, ISBN-10-0135178975

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Electricity and Electronics lab**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**3**

Brief Course Description:

- Measuring currents and voltages in electrical DC and AC circuits, Applying Ohm's and kerchiefs laws, Wining and Operating of Electrical machines, Using of control and protections in power electronics and logic circuits

Course Objectives:

1. Apply Current and voltage measurement in electrical DC and AC circuits
2. Read the electrical diagrams of different HVACR systems
3. Conduct Wiring and operating of electrical machines
4. Use control and protection devices applications in power electronics and logic circuits
5. Under stand and read the Air Conditioning and Heating electrical Circuits

Detailed Course Description:

Unit Number	Content	Time Needed
1.	Investigation of open and closed circuit using a DC voltage source and Resistors connecting in parallel and series	
2.	Measurement of basic electrical quantities using ammeter, voltmeter and avometer	
3.	Electric transformer circuits	
4.	AC current circuit characteristics	
5.	Transistor and rectifier testing	
6.	Using Oscilloscope to study the electrical signals	
7.	Construction of half and full wave rectifier with and without filters	
8.	Logic circuit investigation	
9.	DC motors electrical and mechanical behavior	
10.	Single-phase induction motor operation characteristics	
11.	Construction of simple control loops using relays and cutouts	
12.	Boiler electrical circuit analysis	
13.	Domestic refrigerator electrical circuit analysis	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Laboratory

Text Books & References:

1. ARI Edward F. Mahoney, Electricity, Electronics, and Wiring Diagrams for HVAC/R, 2nd Ed., , Publisher: Prentice Hall, 2006
2. Stephen L. Herman, Bennie Sparkman, "Electricity and Controls for HVAC/R, 5th Edition", ISBN 1-401-89513-1.
3. Russell E. Smith, Electricity for Refrigeration, Heating and Air Conditioning, 6th Edition, ISBN 0-766-87337-4
4. Thomas E. Kissell, Electricity, Electronics, and Control Systems for HVAC, 3rd Edition, ISBN 0-130-09662-8.
5. Edward F. Mahoney, Edward Mahoney Electricity for Air Conditioning and Refrigeration Technicians, 5th Edition, ISBN 0-130-10572-4

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Instrumentation and control**
Credit Hours	**2**
Theoretical Hours	**2**
Practical Hours	**0**

Brief Course Description:

- Concepts of control system, control loops, block diagram, measurements and control of temperature, pressure, flow rate, level and humidity, pneumatic control, fluidic control, electric and electronic control, control actions, overloads, relays and defrost timers

Course Objectives:

Upon successful completion of this course, the student should be able to:

1. Understand the basic concepts and components of control loop
2. Draw the block diagram of control system
3. Explain the method of temperature, pressure, flow rate, level and humidity measurements and control
4. Discuss the difference between the various types of control system
5. Understand the function of overload, relays and defrost timer

Detailed Course Description:

Unit Number	Content		Time Needed
1.		▪ Measurement and Pneumatics control ▪ Testing of Measuring and Pneumatic control devices (Pressure measurements and regulators, Pneumatic relays	
2.		▪ Temperature measurement and control devices ▪ Operation and Testing of Temperature measurement and control devices such as different types of thermostat, Different temperature measurement devices	
3.		▪ Electrical control devices ▪ Operation and testing of Electrical control devices: electronic controller, amplifiers, electrical motors, automatic cutouts, relays, Fuses, magnetic switches	
4.		▪ Domestic Air conditioner control circuit ▪ Control loop elements ▪ Control loop construction ▪ Defects diagnostic in the control loop: short circuit, winding cutout, relays contact melting	
5.		▪ Heating system control system ▪ Control loop elements ▪ Control loop construction ▪ Defects diagnostic in the control loop	
6.		▪ Temperature control system ▪ Control loop elements ▪ Control loop construction ▪ Open and closed loop control systems ▪ Defects diagnostic in the control loop	
7.		▪ Air conditioning and heating control system ▪ Control loop elements ▪ Switching between heating and Air conditioning ▪ Manual control ▪ Different types of automatic control systems	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture

Text Books & References:

References:

1. JohnI. Levenhagen, HVAC Control System Design Diagrams, ISBN 0-070-38129-1.
2. Christopher Underwood, C. P. Underwood, HVAC Control Systems: Modelling, Analysis, and Design, ISBN 0-419-20980-8.
3. John I. Levenhagen, Donald H. and Spethmann, HVAC Controls and Systems, 1st Edition, McGraw-Hill 1993, ISBN 0070375097.
4. S. Don Swenson, HVAC Controls and Control Systems, Prentice Hall, 1994, ISBN-10-0130453609

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Instrumentation and control Lab**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**3**

Brief Course Description:

- Measuring and control elements, Temperature, pressure, flow rate and humidity measurement and control, Control system of cooling, heating and A/C processes, Adjustment. Monitoring & troubleshooting

Course Objectives:

Upon successful completion of this course, the student should be able to:

1. Conduct temperature, pressure, humidity and Air-Fuel ratio measurements and control
2. Test pressure regulator and Thermostat
3. Installation and using of overload, relays and defrost timer
4. Test the Solenoid Valve
5. Differentiate between different type of directional valves used in pneumatic control systems

Detailed Course Description:

Unit Number	Content	Time Needed
1.	Pressure measurements	
2.	Pressure regulators	
3.	Temperature measurements	
4.	Thermostat	
5.	Electrical controlling elements (Relay, overload, contractor)	
6.	Expansion Device	
7.	Temperature and pressure controllers	
8.	Three way controllers	
9.	Air ventilation and air conditioning control system	
10.	Solenoid Valve Controller	
11.	Flow rate Measurement	
12.	Humidity measurement and control	
13.	Air Fuel ratio measurement and control	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Laboratory

Text Books & References:

References:

1. John I. Levenhagen, HVAC Control System Design Diagrams, ISBN 0-070-38129-1
2. Christopher Underwood, C. P. Underwood , HVAC Control Systems: Modelling, Analysis, and Design, ISBN 0-419-20980-8
3. John I. Levenhagen, Donald H. and Spethmann, HVAC Controls and Systems, 1st Edition, McGraw-Hill 1993, ISBN 0070375097.
4. S. Don Swenson, HVAC Controls and Control Systems, Prentice Hall, 1994, ISBN-10-0130453609

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Energy Conversion and Alternatives**
Credit Hours	**2**
Theoretical Hours	**2**
Practical Hours	**0**

Brief Course Description:

- Various sources alternative energy: wind energy, photoelectric energy, solar energy, hydroelectric energy, biomass and alternate fuels, Introduction to energy conservation: energy conservation in building, insulation materials, Active and passive techniques of energy conservation

Course Objectives:

Upon successful completion of this course the student should be able to:

1. Describe the theory of operation of the many different types of alternate energy components and how they produce energy.
2. Analyze the positive and negative aspects of the various alternate energy technologies.
3. Explain the world energy situation.
4. Acquire specific alternate energy information
5. Discuss recommended applications of various alternate energy technologies available and should lead the student to apply this technology in real-life situations.
6. Identify and describe the energy conservation opportunities in industrial and commercial systems
7. Apply energy auditing techniques.
8. Examine the economic evaluation of energy conservation solutions

Detailed Course Description

Unit Number	Content		Time Needed
1.	**Energy Sources and System**	▪ Energy definition and basic concepts. ▪ Forms of energy. ▪ Energy conversion. ▪ Types of energy resources. ▪ Energy mix. ▪ Energy growth patterns. ▪ Energy crisis and its factors	
2.	**Energy Consumption**	▪ Energy sectors within society. ▪ Energy use percentages within each sector. ▪ Current growth patterns of energy and trends. ▪ Various applications. ▪ Energy terminology.	

3.	**Types of Energy**	▪ Coal 1. Coal characteristics. 2. Types of coal. 3. Availability and location of coal resources. 4. Economical and environmental problems associated using coal. 5. Coal gasification and liquefaction. ▪ Petroleum Energy - Availability and location of supplies of oil. - Oil exploration. - Methods of oil production. - Oil transportation. - Pipeline - Water transportation - Tank trucks and railroad cars 5. Oil refining. - Characteristics. - Refining processes. 6. Oil products and their chemistry. 7. Oil shale. - Natural Gas Resources 1. Characteristics of these types of gases: - Natural gas - Liquid petroleum gas 2. Heating value of LPG and natural gas. 3. Associated technology related to: - Distribution and storage of natural gas - Petrochemical industries - Nuclear Energy 1. Basic chemistry of nuclear energy. 2. Nuclear fuel cycle, including: - Mining - Milling	

		- UF6 Production - Enrichment - Fuel fabrication 3. Types of reactors. 4. Nuclear waste: - Characteristics - Waste fuel - Storage of waste. - Volume of waste - Nuclear waste cycle - Hydropower 1. Advantages of hydroelectric power. 2. Present and future of large-scale hydroelectric stations. 3. Pumping storage plants. 4. Small-scale hydroelectric generation. 5. Environmental problems associated with dams and reservoirs. F. Ocean Energy Resources 1. Tidal power. 2. Ocean Thermal Energy Conversion (OTEC). 3. Wave energy. 4. Ocean current power. 5. salinity gradient power. 6. Ocean bioconversion. G. Geothermal Energy 1. Types and uses of geothermal energy. 2. Geothermal resources development. 3. environmental considerations. 4. regional potential of this resource in Jordan and Arab countries. H. Biofuels 1. Gasohol.	

		2. Uncertainties concerning gasohol. 3. Biomass and energy farms. 4. Energy production from waste. 5. Regional advantages. I. Space Base Power 1. Sources of energy possible from space: a. Nuclear b. Sunlight c. Microwave d. Artificial moons e. Fuel cells J. Wind Energy 1. Using wind as a resource. 2. Site selection for small wind machines. 3. Large wind electrical systems. 4. Environmental and economic considerations. 5. Regional advantages for wind power. K. Direct Solar Energy 1. Solar collection. 2. Solar heating systems. 3. properties of solar storage systems. 4. Solar cooling systems. 5 Solar photovoltaic systems.	
4.	**Energy Conversion and Cogeneration**	▪ Common energy converter terminology. ▪ Chemical to thermal to mechanical converters. ▪ Basic electrical principles. ▪ mechanical energy and electrical energy conversion	

5.	**Energy Storage**	▪ Concept of energy storage. ▪ Battery storage technology. ▪ Hydrogen storage technology. ▪ Alternative storage technology	
6.	**Energy Conservation**	▪ Objectives of energy conservation. ▪ Energy conservation in the residential/commercial sector. ▪ Energy conservation in the industrial sector. ▪ Energy conservation in the transportation sector. ▪ Active and passive techniques of energy conservation	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

❖ Lecture

Text Books & References:

References:

1. Peter Gevorkian, Sustainable Energy Systems Engineering: The Complete Green Building Design Resource, 1st Edition
2. Moncef Krarti, Energy Audit of Building Systems: An Engineering Approach, ISBN 0-849-39587-9

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Building Energy Audit Technology**
Credit Hours	**3**
Theoretical Hours	**0**
Practical Hours	**0**

Brief Course Description:

- Teaches the principles of building energy audit techniques to include diagnostic software. During the course the student will perform an energy audit. As a result of the audit, the student will be able to recommend application of the most appropriate energy-saving treatments such as insulation, windows, appliances and HVAC equipment.

Course Objectives:

Upon successful completion of this course, the student should be able to:

1. Understand the physics of energy movement
2. Learn about energy audit tools and test equipment
3. Understand energy saving materials and methods
4. Apply energy audit techniques to various structures

Detailed Course Description:

Unit Number	Content		Time Needed
1.	**Physics of Energy Movement**	▪ Describe Structural heat loss ▪ Describe Infiltration Principles ▪ Describe Temperature ▪ Describe Sensible heat vs. latent heat ▪ Describe Heat loss and gain	
2.	**Energy Audit Tools**	▪ Describe Energy Star Ratings ▪ Describe Detecting air leaks ▪ Blower door, infrared, duct blaster ▪ Describe Using Energy 10 software (online) or other software ▪ Describe Thermography technology and applications	
3.	**Understanding Energy Saving Techniques**	▪ Describe Structural energy saving features such as windows, doors, and insulation ▪ Describe Alternative energy applications that apply to real life situations ▪ Describe Energy saving and water saving appliances ▪ Describe Heating and cooling (HVAC) equipment and systems	
4.	**Applying energy audit techniques to structures**	▪ Describe energy audit assessment in field situations ▪ Describe Using test equipment and tools in field	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture

Text Books & References:

References:

1. Residential Energy, Cost Savings and Comfort for Existing Buildings, John Krigger and Chris Dorsi, ISBN-13: 978-1-880120-09-5
2. Saturn Online and resource program

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Introduction to Solar energy Technology**
Credit Hours	**3**
Theoretical Hours	**0**
Practical Hours	**0**

Brief Course Description:
Earth and sun relation, Solar angle, Solar radiation, Different collector types, .Solar systems, Large PV systems, Photo-voltaic under concentrated sunlight, Passive cooling and heating.

Course Objectives:
Upon successful completion of this course, the student should be able to:

1- Understanding the relation between earth and sun
2- Understanding the analysis of solar radiation on the earth.
3- Understanding the different collector types.
4- Understanding passive cooling and heating

Detailed Course Description:

Unit Number	Content		Time Needed
1.	Introduction to Solar Radiation		
2	Sun earth relations		
3	Available Solar Radiation		
4	Selected Fluid and Heat Transfer Topics		
5	Radiation Characteristics of Opaque Material		
6	Absorbed Radiation		
7	Solar Collectors		
8	PV Systems		
9	Passive designs		

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture

Text Books & References:

1. Solar Energy Thermal Processes, Duffie, J. A. & Beckman, W. A., Johm Willy & Sons
2. Principles of Solar Engineering, Frank Kreth, Jan Kreider, Hemisphere publishing Co
3. Solar Energy Utilization, Rai, G. D., Khanna Publishers.

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Piping Technology and Plumbing Workshop**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**3**

Brief Course Description:
This workshop aims to teach the students how to understand and practice different types of pipes connection and fitting and how to build a central heating set in a building for both hot and cold water networks, and to teach them how to get the proper measurements and sizes during execution.

Course Objectives:
Upon successful completion of this course, the student should be able to:

1. Understand different types and sizes of pipes and tubes
2. Demonstrate understanding of pips connections and fitting
3. Design of Piping Systems (arrangement, supporting, insulation, venting and draining, vessels, Etc
4. Understands pipes symbols and abbreviations
5. Demonstrate and understand cold and hot water systems

Detailed Course Description:

Unit Number	Unit Name	Unit Content	Time Needed
1.	**Pipes and pipe Fitting**	▪ Types of Pipes ▪ Pipes Sizing ▪ Standards and codes (Piping Systems, Pipe, Supports, Flanges, Gaskets, Fittings, Valves, Traps, Pumps, Vessels, Heat Exchangers, Symbols and Screw threads) ▪ Design of Piping Systems (arrangement, supporting, insulation, venting and draining, vessels, Etc..) ▪ Ways of joining pipes ▪ Pipe work calculations (various parameters calculations, terms, run, set, travel.....) ▪ Offsets (welded, two pieces, layout, rolling, around obstacles...) ▪ Pipe fitting terminologies ▪ Fitting methods ▪ Fitting Equipments (in-line Equipment and supporting Equipments) ▪ Beveling, Grindings and cutting ▪ Flanges (types, symbols, dimensions, Etc....) ▪ Valves (types, symbols. Etc....) ▪ Pipe Supports, Pipe Blanking, Elliptical holes and Brackets ▪ Fitting Symbols and abbreviations ▪ Fittings Dimensions & and fitting Tolerances	

2.	**Tube connection**	▪ Cutting, matching, and toothing black and galvanized metal tubes ▪ Determining cutting, joining, and welding defects for all types of tubes ▪ Practical applications to upgrade skills	
3.	**Plumbing technology**	▪ Introducing parts and contents of hot water heating circle for closed and opened systems ▪ Boiler: types, parts, technical specifications, joining and disjoining, maintenance, and comparison between its different types ▪ Burner: types, mechanical and electrical parts, discussing each part function, illustrating specifications for the different types ▪ Joining and disjoining the parts mechanically and electrically, maintenance and repair, determining damages and defects, starting up and calibration ▪ Pumps: Classifications, specifications, parts, methods of insulating and connecting, determining defects and fixing them ▪ Radiators: Types, specifications, parts, technical comparison between their parts, connecting and insulating, introducing its connecting systems and the characteristic of each system. ▪ Cylinder: function, types, methods of insulating and connecting ▪ Chimney: types, specifications, function, maintenance methods.	

		▪ Expansion tank: function, joining methods ▪ Diesel tank: function, specifications, joining methods. ▪ Connection apparatus: shapes, types ▪ Practical applications of joining, grouping, and assembly of hot water heating system.	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- practical

Text Books & References:

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Sheet Metal workshop**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**3**

Brief Course Description:
This course aims to help the student to be able to perform sheet metal works, fabricate, assemble, alter and install a variety of sheet metal products. Sheet metal principles, blue print reading, metal cutting, filling, joining and flat and rectangular fitting fabrication

Course Objectives:
Upon successful completion of this course, the student should be able to:

1. Apply the correct principles of sheet metal pattern development using triangulation, parallel line, and radial line development.
2. Read and use blueprints and specifications to estimate, fabricate and install sheet metal items.
3. Know, and be able to apply their knowledge of the advantages and limitations of various types of sheet metal used in the trade including non-metallic materials such as plastics.
4. Co-ordinate sheet metal work with other trades on the job site.

Detailed Course Description:

Unit Number	Unit Name	Unit Content	Time Needed
1.	**Sheet works and drafting tools**	▪ Basic marking tools (trammel, markers, dot marker, gauge marker.) ▪ Drawing on simple flat work pieces ▪ Drawing on cylindrical work pieces ▪ Repairing work pieces and removing chip and dust. ▪ Practical applications on sheets using drawing tools	
2.	**Metal cutting**	▪ Cutting by using manual and fixed automatic cutters. ▪ Cutting by using manual and electrical metal saws. ▪ Cutting by using files. ▪ Practical applications like rounded cutting, angular cutting, pipe and flat iron shearing, making hollow shapes.	
3.	**Filing**	▪ File types, categories, and applications. ▪ File handling and fixing work pieces on vice. ▪ Practical applications like filing square and flat iron shapes with different sizes.	
4.	**Metal joining**	▪ Manual and mechanical drilling tools; their types and proper speeds. ▪ Methods of metal joining - joining by screws, joining by rivets, joining by welding.	

		▪ Practical applications including drilling of different sheets and flat pieces, and choosing the best rivet for drilling and joining metals.	
5.	**Flat and Rectangular Fitting Fabrication**	▪ Apply pattern development techniques to shop applications. ▪ Describe how to form pieces for flat rectangular fittings. ▪ Describe how to form duct connection joints. ▪ Describe how to assemble various types of fittings. ▪ Describe how to join duct fittings together. ▪ Fabricate and assemble plenum takeoffs with common shop tools. ▪ Fabricate and assemble rectangular duct reducers with common shop tools. ▪ Fabricate and assemble regular or change tees or tap-in takeoffs c/w curved throats and heels with ▪ common shop tools. ▪ Fabricate and assemble regular or change rectangular 90° elbows with common shop tools. ▪ Fabricate and assemble rectangular regular or change Ybranch with common shop tools. ▪ Fabricate and assemble regular or change rectangular offsets with ogee curves with common shop tools. ▪ Fabricate and assemble sleeves (e.g. fire damper, wall sleeves) with common shop tools. ▪ Fabricate and assemble rectangular and round flex connectors with common shop tools.	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Practical

Text Books & References:

References:

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Solar Thermal Systems I**
Credit Hours	**2**
Theoretical Hours	**2**
Practical Hours	**0**

Brief Course Description:

- Determine and utilize available solar energy, sizing of an appropriate auxiliary heating/ cooling system in conjunction with good thermal control. Passive and active solar, ventilation and indoor air quality, analysis and sizing of small auxiliary heating/cooling systems, control of passive solar buildings. Utilize solar energy equipment, techniques and systems, solar water heating, flat plate collectors and concentrators, pumps and controllers.

Course Objectives:

Upon completion of this course, students will be able to

1. Define the principles of solar energy
2. Describe the components of a solar thermal system
3. Apply basic sizing methods
4. Understand system design
5. Compare various types of systems
6. Describe equipment locations within systems

Detailed Course Description:

Unit Number	Unite name	Unite content	Time Needed
1.	**Principles of Solar Energy**	Types of solar thermal systems ▪ Site analysis and selection ▪ Cost vs. energy payback ▪ Safety methods and regulations	
2.	**Solar Thermal Components**	▪ Collectors ▪ Piping ▪ Pumps and pump assemblies ▪ Thermal storage ▪ Heat exchangers ▪ Controls and controllers	
3.	**Sizing of thermal systems**	▪ Energy Audit / load determination ▪ Heating Load ▪ System Capacity ▪ System parameters	
4.	**System Design**	▪ Evaluating collectors ▪ Heat transfer fluids ▪ System efficiency ▪ Storage need to load ▪ Collector area to storage	
5.	**Solar Controllers**	▪ Differential Temperature Types ▪ Thermostats, Sensors, Aquastats	
6.	**Commissioning**	▪ Start-up procedures ▪ System performance evaluation ▪ Balancing the system ▪ Documentation	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture

Text Books & References:

References:

1. Solar Thermal Water Heating, Bob Ramlow, ISBN:978-0-86571-668-1
2. Solar Heating and Cooling of Residential buildings - Sizing, Installation, and Operation of Systems: Colorado State University, ISBN: 1-4102-2459-7

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Solar Thermal Energy II**
Credit Hours	**2**
Theoretical Hours	**2**
Practical Hours	**0**

Brief Course Description:

- Advanced sizing and design concepts. Applying the solar resource to varying structures, determining piping paths, interpreting design drawings. Utilize and compare design software. Explore solar related construction techniques for new and retrofit construction applications.

Course Objectives:

Upon completion of this course, students will be able to

1. Describe advanced design concepts
2. Describe solar concepts of multi-use systems
3. Describe solar storage integration with hydronic heating
4. Apply solar energy to commercial use systems
5. Apply concepts for Solar spa and pool heating – Residential and Commercial
6. Describe troubleshooting means and methods

Unit Number	Unite name	Unite content	Time Needed
1.	**Review of Basic System Types**	Types of solar thermal systems ▪ Thermosyphon ▪ Closed Loop ▪ Open Loop ▪ Drain Back	
2.	**Understanding Advanced Systems**	▪ Building Heating systems ▪ Hydronic ▪ Forced Air ▪ Industrial Heat Systems ▪ Multiple Storage Systems ▪ Multiple Controllers and Controls ▪ Advanced Transfer fluids	
3.	**Sizing Larger Systems**	▪ Energy Audit / load determination ▪ Heating Load ▪ System Capacity ▪ System parameters	
4.	**Advanced System Design**	▪ Evaluating collector arrays ▪ System efficiency ▪ Storage need to load ▪ Collector/Type area to storage ▪ Storage integration to distribution ▪ Building integration ▪ Evaluate Software	
5.	**Solar Controllers**	▪ Programmable Controllers ▪ Multifunction Controllers	
6.	**Troubleshooting and Maintenance**	▪ System Assessment ▪ System performance evaluation ▪ Troubleshooting ▪ Documentation ▪ System Maintenance plan	
7.	**Cost Analysis and Payback**	▪ Value Engineering ▪ Return on Investment	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture

Text Books & References:

References:

7. Solar Thermal Water Heating, Bob Ramlow, ISBN:978-0-86571-668-1
8. Solar Heating and Cooling of Residential buildings - Sizing, Installation, and Operation of Systems: Colorado State University, ISBN: 1-4102-2459-7

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Solar Thermal Workshop I**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**6**

Brief Course Description:

- Demonstrate solar thermal panels, system components and installation techniques. The student will apply the principles of solar energy, site analysis, cost vs. payback, sizing, energy audit, and solar system design into a project. the student will learn additional system control and operation techniques. Includes system and equipment troubleshooting.

Course Objectives:

Upon successful completion of this course, the student should be able to:

1. Demonstrate mounting of collectors and equipment for various systems
2. Demonstrate wiring of control systems and sensors
3. Demonstrate flush and fill methods
4. Demonstrate start up

Detailed Course Description:

Unit Number	Unite name	Unite content	Time Needed
1.	**Safety and tool use**	▪ Use of proper personal protective equipment ▪ Demonstrate proper tool use ▪ Use of testing equipment	
2.	**Site Analysis**	▪ Demonstrate Solar Pathfinder ▪ Orientation of array ▪ Determine best orientation	
3.	**Installation of collector support structure**	▪ Demonstrate layout of system on structure ▪ Demonstrate attachments into structure ▪ Demonstrate assembly of support frames ▪ Demonstrate attachment of collectors to frames	
4.	**Installation of thermal Storage**	▪ Installation of storage system ▪ Demonstrate Series and Parallel piping of storage ▪ Installation of pressure relief ▪ Demonstrate Insulation methods ▪ Demonstrate installation of air relief and drain valves	
5.	**Installation of pump systems**	▪ Demonstrate proper placement of components ▪ Proper pump orientation ▪ Air and pressure relief components ▪ Demonstrate installation of valves, meters and gauges.	
6.	**Commissioning/ Start Up**	▪ Demonstrate air pressure testing ▪ Demonstrate filling of system, removal of air ▪ Demonstrate testing and final operation	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture and Demonstration

Text Books & References:

1.

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Solar Thermal Workshop II**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**6**

Brief Course Description:

- Apply solar thermal panels, system components and installation advanced techniques. The student will apply the principles of solar energy, site analysis, cost vs. payback, sizing, energy audit, and solar system design into a project. the student will learn additional system control and operation techniques. Includes system and equipment troubleshooting.

Course Objectives:

Upon successful completion of this course, the student should be able to:

1. Demonstrate equipment locations for various advanced thermal systems
2. Demonstrate wiring of control systems and sensors
3. Demonstrate mixing of heat transfer fluids
4. Demonstrate troubleshooting procedures

Detailed Course Description:

Unit Number	Unite name	Unite content	Time Needed
1.	**Equipment locations in advanced systems**	▪ Demonstrate Schematic design of various systems ▪ Demonstrate reasoning for equipment locations ▪	
2.	**Advanced Control Systems**	▪ Demonstrate mounting off programmable controllers ▪ Demonstrate operation of programmable controller	
3.	**Installation of collector array**	▪ Demonstrate racking and attachment of multiple collector array ▪ Demonstrate piping of array ▪ Series piping ▪ Parallel piping ▪	
4.	**Installation of thermal Storage**	▪ Demonstrate multiple tank configuration ▪ Demonstrate Series and Parallel piping of tanks ▪ Demonstrate a Drain-back storage system ▪ Demonstrate a Drain-Down storage system	
5.	**Installation of circulation loops**	▪ Demonstrate proper pump placement ▪ Demonstrate location and purpose of balancing valves ▪ Demonstrate heat transfer fluids and mixing requirements ▪ Demonstrate installation of check valves	

		▪ Demonstrate location of drain valves ▪	
6.	**System Integration**	▪ Demonstrate solar system integration with hydronic heating ▪ Demonstrate solar system integration with forced air heating ▪ ▪	
7.	**Troubleshooting and Maintenance**	▪ Demonstrate total system assessment ▪ Demonstrate performance evaluation of system ▪ Determine corrective action or remedy ▪ Documentation ▪ Demonstrate a maintenance plan and schedule	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture and Demonstration

Text Books & References:

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Photovoltaic System I**
Credit Hours	**2**
Theoretical Hours	**0**
Practical Hours	**0**

Brief Course Description:

Introduce and explain the theory and operational principles of Photovoltaic systems. Physics behind the steps, conversion of electromagnetic radiation into electrical energy. Basic structure of solar cells, solar cell function, limitations on energy conversion in solar cells, concepts for improving the efficiency of solar cells, PV arrays and other components. Principles of electricity and how to effectively and safely incorporate them into electrical systems.

Course Objectives:

Upon successful completion of this course, the student should be able to:

1. Solar Resource/Site Evaluation
2. Understand and compare Grid Interactive Components
3. Describe testing and evaluation methods
4. Perform a payback analysis
5. Describe safe installation practices
6. Describe Commissioning and Troubleshooting procedures

Detailed Course Description:

Unit Number	Unite name	Unite content	Time Needed
1.	**Safety and tool use**	▪ Use of proper personal protective equipment ▪ Demonstrate proper tool use ▪ Use of testing equipment	
2.	**Site Analysis**	▪ Describe Magnetic Declination ▪ Describe Compass Use ▪ Describe Solar Pathfinder ▪ Describe Irradiance meter ▪ Orientation of array ▪ Determine best orientation ▪ Determine solar resource	
3.	**Grid-Interactive System Types**	▪ Grid Interactive Direct Systems ▪ Grid Interactive with Back-up ▪ Grid Interactive Hybrid	
4.	**Photovoltaic Components**	▪ Describe Module types and operation and ratings ▪ Describe Inverter types and operation ▪ Describe Wiring methods ▪ Describe Overcurrent Protection ▪ Describe Disconnect methods	
5.	**Mechanical Integration**	▪ Describe module mounting methods ▪ Describe Balance of System components and mounting ▪ Calculate environmental effects on modules and rack structure	
6.	**Electrical Integration**	▪ Calculate module voltages ▪ Evaluate module string voltages to inverter voltage window ▪ Calculate wire sizes ▪ Describe Equipment grounding ▪ Calculate voltage drop ▪ Calculate overcurrent protection	

7.	**Grid Interactive PV Commissioning**	▪ Describe visual system inspection ▪ Describe electrical tests ▪ Describe commissioning procedure ▪ Describe testing of system performance	
8.	**Grid Interactive Troubleshooting**	▪ Evaluate existing system parameters ▪ Describe required Electrical Testing ▪ Describe correction options and methods	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

❖ Lecture

Text Books & References:

References:

1. Photovoltaic Systems, Second Edition, James P. Dunlop, ISBN: 978-0-8269-1308-1
2. Photovoltaics Design and Installation Manual, Solar Energy International, ISBN:978-0-86571-520-2

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Photovoltaic Systems II**
Credit Hours	**2**
Theoretical Hours	**0**
Practical Hours	**0**

Brief Course Description:

Continued theory and operational principles involved with battery based off-grid photovoltaic systems. Conversion of electromagnetic solar energy conversion to electrical energy to stored chemical energy in batteries and other storage methods. Students will learn about direct coupled, self-regulating, charge controlled systems along with remote and local off-grid and battery backed up applications.

Course Objectives:

Upon successful completion of this course, the student should be able to:

1. Describe proper safety applications relative to battery based PV systems
2. Ability to apply critical design criteria for Photovoltaic battery based systems
3. Describe and compare various Photovoltaic and battery system based components
4. Describe System Sizing process
5. Describe criteria for component selection

Detailed Course Description:

Unit Number	Content		Time Needed
1.	**Battery System differences from Grid Interactive Systems**	▪ Describe added Personal Protective Equipment ▪ Describe module requirements ▪ Describe Inverter requirements ▪ Describe Battery functions ▪ Describe Charge Controller in circuit ▪ Describe solar resource requirements	
2.	**Battery Fundamentals**	▪ Describe Battery Types ▪ Describe Battery Electrolyte Requirements ▪ Describe Battery Functions ▪ Describe Environmental Effects on Batteries ▪ Describe Operational Effects on Batteries ▪ Describe battery voltage and amp hour calculations ▪ Describe Battery Enclosure requirements	
3.	**Charge Controller Fundamentals**	▪ Describe Charge Controller functions ▪ Describe Types of charge controllers ▪ Describe operational characteristics of charge controllers ▪ Describe charge controller selection	
4.	**Battery / PV System Sizing**	▪ Describe Battery bank sized to Daily load ▪ Describe Photovoltaic system sized to battery bank ▪ Describe Inverter sizing to operation requirements ▪ Describe Charge Controller Selection for system	
5.	**Battery System Mechanical Integration**	▪ Describe module mounting requirements ▪ Describe location for batteries and Inverter ▪ Thermal and Sound Insulation ▪ Describe system enclosure / weather protection requirements	

6.	**Stand Alone System Electrical Integration**	▪ Describe series and parallel circuit requirements of modules ▪ Describe series and parallel wiring requirements of batteries ▪ Describe wire sizes requirements of various circuits in system ▪ Describe overcurrent protection in circuits ▪ Describe disconnect methods for equipment ▪ Describe Equipment Grounding Requirements	
7.	**Stand Alone System Commissioning**	▪ Describe Visual Inspection ▪ Describe Electrical testing ▪ Describe start up procedure ▪ Describe Evaluation procedure ▪	
8.	**Stand Alone Troubleshooting**	▪ Describe system evaluation process ▪ Describe system parameters ▪ Describe levels of assessment ▪ Describe correction methods ▪ Describe re-evaluation process	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Lecture

Text Books & References:

1. Photovoltaic Systems, Second Edition, James P. Dunlop, ISBN: 978-0-8269-1308-1
2. Photovoltaics Design and Installation Manual, Solar Energy International, ISBN:978-0-86571-520-2

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Photovoltaic System Workshop I**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**6**

Brief Course Description:
Students learn about current solar collection and conversion equipment, and sizing of Grid-Interactive and to install with maximum performance. They will layout and orient these systems using standard industry tools and testing equipment. Conduit bending, wiring and roof attachments are part of the course as well. Students explore the trouble areas as they might encounter while servicing a PV system.

Course Objectives:
Upon successful completion of this course, the student should be able to:

1. Demonstrate and conduct a site survey/analysis
2. Draw a site plan
3. Draw a photovoltaic system on a site plan
4. Install a Grid Interactive Photovoltaic System
5. Demonstrate commissioning of an installed PV system

Detailed Course Description:

Unit Number	Content		Time Needed
1.	**Site Survey**	▪ Demonstrate compass use ▪ Demonstrate site selection ▪ Demonstrate Solar Pathfinder use ▪ Draw a site plan ▪ Demonstrate resource assessment ▪ Demonstrate layout of system on structure	
2.	**Installation of PV modules**	▪ Demonstrate rack attachments to structure ▪ Demonstrate racking assembly/ Installation ▪ Demonstrate module attachments to racking ▪ Demonstrate equipment grounding of modules	
3.	**Electrical Connections**	▪ Demonstrate installation of electrical panels and disconnects ▪ Demonstrate installation of overcurrent devices ▪ Demonstrate installation of wire of correct sizes/diameters/insulation requirements	
4.	**System Commissioning**	▪ Demonstrate a visual inspection ▪ Demonstrate final wire connections from modules (power source) ▪ Demonstrate Voltage testing at wire terminations ▪ Demonstrate operation of Inverter ▪ Demonstrate interaction with Grid power ▪ Demonstrate system operation in relation to irradiance and temperature	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Laboratory

Text Books & References:

References:

1. Photovoltaic Systems, Second Edition, James P. Dunlop, ISBN: 978-0-8269-1308-1
2. Photovoltaics Design and Installation Manual, Solar Energy International, ISBN:978-0-86571-520-2

Engineering Program

Specialty	**Solar Energy Technology**
Course Number	
Course Title	**Photovoltaic System Workshop II**
Credit Hours	**1**
Theoretical Hours	**0**
Practical Hours	**6**

Brief Course Description:

- Students learn about design and sizing of Stand Alone PV systems and to install with maximum performance. They will layout and orient these systems using standard industry tools and testing equipment. Installation of batteries, control systems and monitoring systems is part of this course. Students explore the trouble areas as they might encounter while servicing a PV system and create a maintenance plan.

Course Objectives:

Upon successful completion of this course, the student should be able to:

1. Design a Stand Alone system schematic plan
2. Assemble a small Stand-Alone DC Output Photovoltaic system
3. Install a Stand-Alone AC output Photovoltaic system
4. Demonstrate commissioning and Troubleshoot an installed PV system

Detailed Course Description:

Unit Number	Content		Time Needed
1.	**Sizing and Design of Stand Alone PV system**	▪ Demonstrate Load Analysis ▪ Demonstrate Battery Storage sizing ▪ Demonstrate Array sizing ▪ Demonstrate Charge Controller sizing ▪ Demonstrate Inverter sizing/selection ▪ Demonstrate Equipment selection ▪ Demonstrate Design drawing	
2.	**Installation of Inverter and Charge Controller**	▪ Demonstrate installation of Inverter ▪ Demonstrate installation of Charge Controller ▪ Demonstrate installation of wire raceways to equipment	
3.	**Installation of Battery Bank**	▪ Demonstrate installation of Battery Enclosure ▪ Demonstrate battery ventilation method(s) ▪ Demonstrate electrolyte spill containment ▪ Demonstrate control of gases	
4.	**Electrical Connections**	▪ Demonstrate installation of electrical panels and disconnects ▪ Demonstrate installation of overcurrent devices ▪ Demonstrate installation of wire of correct sizes/diameters/insulation requirements	
5.	**System Commissioning**	▪ Demonstrate a visual inspection ▪ Demonstrate final wire connections from modules (power source) ▪ Demonstrate Voltage testing at wire terminations	

		▪ Demonstrate operation of Charge Controller ▪ Demonstrate operation of Inverter ▪ Demonstrate application of a load to system ▪ Demonstrate system operation in relation to irradiance and temperature	
6.	**Maintenance**	Demonstrate a Battery maintenance and service plan	
7.	**Stand Alone Troubleshooting**	▪ Demonstrate system evaluation process ▪ Describe system parameters ▪ Describe levels of assessment ▪ Describe correction methods ▪ Describe re-evaluation process	

Evaluation Strategies:

Exams		Percentage	Date
Exams	First Exam	20%	--/--/----
	Second Exam	20%	--/--/----
	Final Exam	50%	--/--/----
Homework and Projects		10%	
Discussions and lecture Presentations			

Teaching Methodology:

- Laboratory

Text Books & References:

References:

1. Photovoltaic Systems, Second Edition, James P. Dunlop, ISBN: 978-0-8269-1308-1
2. Photovoltaics Design and Installation Manual, Solar Energy International, ISBN:978-0-86571-520-2