57. Course Specification of Renewable Energy Technology

I. Course Identification and General Information:

.1	Course Title:	Renewable Energy Technology.				
.2	Course Code & Number:	MT310.				
.3	Credit hours:	C.H.				TOTAL C.R. Hrs.
		Th.	Seminar	Pr	Tu.	
		2	-	-	2	3
.4	Study level/ semester at which this course is offered:	Fourth Year -Second Semester.				
.5	Pre –requisite (if any):	Mathematics, Physics ,Thermodynamics and Heat Transfer.				
.6	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	Mechatronics Engineering Department.				
8.	Language of teaching the course:	English Language.				
.9	Location of teaching the course:	Mechatronics Engineering Department..				
10.	Prepared By:	Associate Prof. Dr. Abdul-Malik Momin.				
11.	Date of Approval:					

II.Course Description:

This introductory course of Renewable Energy Technology will provide in-depth understanding of the technology, applications, economics and policies relevant to each type of energy source. In this course, an overview of various renewable energy technologies and sustainable design practices and their current applications will be taken as: the details of Solar Thermal Energy, Solar Photovoltaics, Wind, Geothermal Energy, Hydro, Wave and Tidal. Emphasis will be placed on energy production efficiency and conservation. This course would review the renewable sources and their need in world energy scenario. The course also includes a research project in which students would be required to do a detailed literature survey analysis taking into account economics of power generation and cost, performance and reliability.

	III.Course Intended learning outcomes (CILOs) of the course	Referenced PILOs
a1.	Label different engineering management principles and their developments.	A5
a2.	Depict the impact on society.	A7

b1.	Analyze problems with the support of the renewable energy technology.	B1
b2.	Explore innovative solutions to support industrial applications.	B3
b3.	Combine fundamental parameters to reach to standard products.	B5
c1.	Solve engineering problems with the support of the software related to the subject (for example homer).	C2
c2.	Implement feasibility studies.	C4
d1.	Co-operate with team members to share different knowledge.	D1
d2.	Assess to tasks with the support of the different resources.	D3
d3.	Evaluate technical reports.	D6

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Complete data collection. **a1.**	• Active Lectures. • Tutorials.	• Written Assessment. • Short Essays.
Depict the impact on society. **a2.**	• Active Lectures.	• Presentation.

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Analyze problems with the support of the renewable energy technology. **b1.**	• Design Work and Project. • Case Studies	• Practical Assessment. • Reports.
Explore innovative solutions to support industrial applications. **b2.**	• The use of Computer and Web-Based Learning. • Case Studies.	• Practical Assessment. • Project Reports.
Combine fundamental parameters to reach to standard products. **b3.**	• Active Lectures. • Case studies.	• Practical Assessment. • Presentations.

© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Solve engineering problems with the support of the software. **c1.**	• Active Lectures. • The use of Computer and Web-Based Learning.	• Reports. • Presentations.

Implement feasibility studies. **c2.**	• Active Lectures.	• Reports.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
Co-operate with team members to share different knowledge. **d1.**	• Directed Self Study.	• Project Reports.
Assess to tasks with the support of the different resources. **d2.**	• Group Learning and Problem-Based Learning..	• Presentations.
Evaluate technical reports. **d3.**	• Directed Self Study.	• Reports.

IV.Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Solar Energy Utilization.	a1, b1, b2, d1, d2.	• Renewable Energy Resources. • Strategies of Ministry of Electricity and Energy. • Solar Energy Spectrum. • Solar Geometry and Collector Angles. • Solar Radiation. • Solar Radiation Outside the Earth's Atmosphere. • The Solar Constant. • Instruments for Measuring Solar Radiations. • Solar Radiation on the Tilted Surface. • The Most Common Weather Tools such as: Thermometer, Wind Vane, Anemometer, Barometer and Rain Gauge. • Meteorological Data. • Modes of Heat Transfer.	2	4

2.	Flat Plate Collectors (Liquid and Air Heaters).	a1, a2, b1, b2, b3, c1, d1, d2, d3.	• Description of Liquid Flat Plate Collectors. • Performance Analysis. • Collector Overall Loss Coefficient. • Effects of Various Parameters on the Performance of the Collector. • Solar Air Heaters. • Performance Analysis of a Conventional Air Heater. • Solar Air Dryer.	2	4
3.	Concentrating Collector.	a1, a2, b1, b2, b3, c1, d1, d2, d3.	• Cylindrical Parabolic Collector. • Parabolic Dish Collector. • Central Receiver Collector.	1	2
4.	Photovoltaic System.	a1, a2, b1, b2, b3, c1, d1, d2, d3.	• Photovoltaic Technology. • What are Photovoltaic Cells? • How does it Work? • Photovoltaic Effect. • Commercial Solar Cells. • Cells, Modules and Arrays. • Typical PV System.	1	2
5.	Wind Power Technology.	a1, a2, b1, b2, b3, c1, d1, d2, d3.	• How does a Wind Turbine Work? • Materials for Turbine Blades. • Wind Mill Design. • Modern Wind Turbines: Horizontal Axis Wind Turbine (HAWT). • Vertical Axis Wind Turbine (VAWT). • Large Wind Turbine. • Wind Farms. • Power and Energy Relationship.	2	4

			• Wind Project Development Process.		
6	Mid-Term Exam.	a1, b1, b2, b3, c1,	• The First 5 Chapters.	1	2
7.	Hydro Power Technology.	a1, a2, b1, b2, b3, c1, d1, d2, d3.	• Hydrologic Cycle. • Introduction to Hydro-Power Plant. • Types of Hydro-Power Installation. • Classifications of Hydro Turbines. • Efficiency Calculation. • Cost of Hydro-Electric Power Plant.	2	4
8.	Geothermal Energy Technology.	a1, a2, b1, b2, b3, c1, d1, d2, d3.	• Geothermal Energy-An Overview. • High Enthalpy Regions. • Flashing System. • Geothermal Aquifer. • World Geothermal Resources. • The Physics of Geothermal Energy. • Technologies for Geothermal Exploitation. • Hot Dry Rock.	1	2
9.	Biomass, Wave and Tidal Technology.	a1, a2, b1, b2, b3, c1, d1, d2, d3.	• Biomass and Some Basic Data. • Biomass Contribution to Primary Energy. • Tropical Crop Wastes. • Animal Wastes. • Basic Science of the Tides. • Future Expansion of Tidal Turbines. • Types of Generators.	1	2

10.	Hybrid System Technology.	a1, a2, b1, b2, b3, c1, d1, d2, d3.	• Introduction to Hybrid Power Generation. • Description of Hybrid System. • Solar/Wind/Diesel System. • Hybrid Control. • Monitoring Systems. • Diesel Power Plant Working Principle.	1	2
11.	Project Cost Estimation and Economic Analysis.	a1, a2,b1, b2, b3, c1, c2, d1, d2, d3.	• Learning Objectives. • Cost Estimation. • Cost Management Plan. • Cost Concepts. • Costs of Solar Process Systems. • Uncertainties in Economic Analysis. • Payback Period.	1	2
12.	Final Exam.	a1, b1, b2, b3, c1,	• All the Chapters.	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B- Tutorial Aspect:-

Order	Tasks/ Experiments	Number of Weeks	Contact hours	Learning Outcomes
1.	Solar Energy Utilization.	1,2	4	a1, b1, b2, d1, d2.
2.	Flat Plate Collectors (Liquid and Air Heaters).	3,4	4	a1, a2, b1, b2, b3, c1, d1, d2, d3.
3.	Concentrating Collector.	5	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
4.	Photovoltaic System.	6	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
5.	Wind Power Technology.	7,8	4	a1, a2, b1, b2, b3, c1, d1, d2, d3.
6.	Hydro Power Technology.	9,10	4	a1, a2, b1, b2, b3, c1, d1, d2, d3.
7.	Geothermal Energy Technology.	11	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.

8.	Biomass, Wave and Tidal Technology.	12	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
9.	Hybrid System Technology.	13	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
10.	Project Cost Estimation and Economic Analysis.	14	2	a1, a2,b1, b2, b3, c1, c2, d1, d2, d3.
Number of Weeks /and Units Per Semester: 14			**28**	

V.Teaching strategies of the course:

- Active Lectures.
- Tutorials.
- The use of Computer and Web-Based Learning.
- Design Work and Project.
- Case Studies.
- Independent Learning.
- Directed Self Study.
- Group Learning and Problem Based Learning.

VI.Assignments:

No	Assignments	Aligned CILOs (symbols)	Week Due	Mark
1.	Tutorials (Chapter 1- Chapter 10).	a1, b1, b2, d1, d2.	1-14	20
Total				**20**

VII.Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Assessment (Work Sample such as Portfolios).	1-14	20	13.33 %	a1, a2, b1, b2, b3, c1, c2, d1, d2, d3.
2.	Mid-Term Exam.	9	25	16.67 %	a1, b1, b2, b3, c1.
3.	Final Exam.	16	105	70 %	a1, b1, b2, b3, c1.
Total			**150**	**100%**	

VIII.Learning Resources:

- Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).

	1- Required Textbook(s) (maximum two).
	1. S.P. Sukhumi, 1998, Solar Energy-Principles of Thermal Collection and Storage, Se Edition, Tata McGraw Hill. 2. Dr. P.C. Sharma, 2000, Power Plant Engineering, Sixth Edition, S.K. Katarina and Son 3. P.K. Nag, 2008, Power Plant Engineering, Third Edition, Tata McGraw Hill.
	2- Essential References.
	1. John A. Duffy and William A. Beckman, 1980, Solar Engineering of Thermal Processe Second Edition, John Wiley & Sons Inc.
	3- Electronic Materials and Web Sites *etc*.
	1. www.environmentalsciencedegree.com. 2. www.irena.org. 3. www.renewable-technology.com.

	IX.Course Policies:
.1	**Class Attendance:** - The students should have more than 75% of attendance according to rules and regulations of the faculty.
.2	**Tardy:** - The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture.
.3	**Exam Attendance/Punctuality:** - The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam.
.4	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
.5	**Cheating:** - If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquiries.
6.	**Plagiarism:** - If one student attends the exam on another behalf; he will be dismissed from the faculty according to the policy, rules and regulations of the university.
7.	**Other policies:** - All the teaching materials should be kept out the examination hall and mobile phones are not allowed. - Mutual respect should be maintained between the student and his teacher and also among students. Failing in keeping this respect is subject to the policy, rules and regulations of the university.

Reviewed By	Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat. President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi.
	Deputy Rector for Academic Affairs Assoc. Prof. Dr. Ibrahim AlMutaa. Assoc. Prof. Dr. Ahmed Mujahed. Asst. Prof. Dr. Munaser Alsubari.

Head of the Department Assoc. Prof. Dr. Abdul-Malik Momin	Quality Assurance Unit Assoc. Prof. Dr. Mohammad Algorafi	Dean of the Faculty Prof. Dr. Mohammed AL-Bukhaiti	Academic Development Center & Quality Assurance Assoc. Prof. Dr. Huda Al-Emad	Rector of Sana'a University Prof. Dr. Al-Qassim Mohammed Abbas

Course Plan of Renewable Energy Technology

I.Information about Faculty Member Responsible for the Course:

		Office Hours					
Name of Faculty Member	Assoc. Prof. Dr. Abdul-Malik Momin						
Location& Telephone No.	Mechatronics Engineering Department 777943334.	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	dramalikmomin@yahoo.com						

II.Course Identification and General Information:

1.	Course Title:	Renewable Energy Technology.				
2.	Course Number & Code:	MT310.				
3.	Credit hours:	**C.H**				**Total Cr. Hrs.**
		Th.	**Seminar**	**Pr.**	**Tu.**	
		2	-	-	2	3
4.	Study level/year at which this course is offered:	Fourth Year -Second Semester.				
5.	Pre –requisite (if any):	Mathematics, Physics, Thermodynamics and Heat Transfer.				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Mechatronics Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	System of Study:	Semesters.				
10.	Mode of delivery:	Lectures and Tutorials.				
11.	Location of teaching the course:	Mechatronics Engineering Department.				

III.Course Description:

This introductory course of Renewable Energy Technology will provide in-depth understanding of the technology, applications, economics and policies relevant to each type of energy source. In this course, an overview of various renewable energy technologies and sustainable design practices and their current applications will be taken as: the details of Solar Thermal Energy, Solar Photovoltaics, Wind, Geothermal Energy, Hydro, Wave and Tidal. Emphasis will be placed on energy production efficiency and conservation. This course would review the renewable sources and their need in world energy scenario. The course also includes a research project in which students would be required to do a detailed literature survey analysis taking into account economics of power generation and cost, performance and reliability.

Head of the Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance	Rector of Sana'a University
Assoc. Prof. Dr. Abdul-Malik Momin	Assoc. Prof. Dr. Mohammad Algorafi	Prof. Dr. Mohammed AL-Bukhaiti	Assoc. Prof. Dr. Huda Al-Emad	Prof. Dr. Al-Qassim Mohammed Abbas

IV.Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1	Label different engineering management principles and their developments.	A5
a2	Depict the impact on society.	A7
b1.	Analyze problems with the support of the renewable energy technology.	B1
b2.	Explore innovative solutions to support industrial applications.	B3
b3	Combine fundamental parameters to reach to standard products.	B5
c1.	Solve engineering problems with the support of the software related to the subject (for example hommer).	C2
c2	Implement feasibility studies.	C4
d1.	Co-operate with team members to share different knowledge.	D1
d2.	Assess to tasks with the support of the different resources.	D3
d3	Evaluate technical reports.	D6

V.Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1.	Solar Energy Utilization.	• Renewable Energy Resources. • Strategies of Ministry of Electricity and Energy. • Solar Energy Spectrum. • Solar Geometry and Collector Angles. • Solar Radiation. • Solar Radiation Outside the Earth's Atmosphere. • The Solar Constant. • Instruments for Measuring Solar Radiations. • Solar Radiation on the Tilted Surface. • The Most Common Weather Tools such as: Thermometer, Wind Vane, Anemometer, Barometer and Rain Gauge. • Meteorological Data. • Modes of Heat Transfer.	1,2	4
2.	Flat Plate Collectors (Liquid and Air Heaters).	• Description of Liquid Flat Plate Collectors. • Performance Analysis. • Collector Overall Loss Coefficient. • Effects of Various Parameters on the Performance of the Collector.	3,4	4

		• Solar Air Heaters. • Performance Analysis of a Conventional Air Heater. • Solar Air Dryer.		
3.	Concentrating Collector.	• Cylindrical Parabolic Collector. • Parabolic Dish Collector. • Central Receiver Collector.	5	2
4.	Photovoltaic System.	• Photovoltaic Technology. • What are Photovoltaic Cells? • How does it Work? • Photovoltaic Effect. • Commercial Solar Cells. • Cells, Modules and Arrays. • Typical PV System.	6	2
5.	Wind Power Technology.	• How does a Wind Turbine Work? • Materials for Turbine Blades. • Wind Mill Design. • Modern Wind Turbines: Horizontal Axis Wind Turbine (HAWT). • Vertical Axis Wind Turbine (VAWT). • Large Wind Turbine. • Wind Farms. • Power and Energy Relationship. • Wind Project Development Process.	7,8	4
6.	Mid-Term Exam.	• The First 5 Chapters.	9	2
7.	Hydro Power Technology.	• Hydrologic Cycle. • Introduction to Hydro-Power Plant. • Types of Hydro-Power Installation. • Classifications of Hydro Turbines. • Efficiency Calculation. • Cost of Hydro-Electric Power Plant.	10,11	4
8.	Geothermal Energy Technology.	• Geothermal Energy-An Overview. • High Enthalpy Regions. • Flashing System. • Geothermal Aquifer. • World Geothermal Resources. • The Physics of Geothermal Energy. • Technologies for Geothermal Exploitation. • Hot Dry Rock.	12	2

9.	Biomass, Wave and Tidal Technology.	• Biomass and Some Basic Data. • Biomass Contribution to Primary Energy. • Tropical Crop Wastes. • Animal Wastes. • Basic Science of the Tides. • Future Expansion of Tidal Turbines. • Types of Generators.	13	2
10.	Hybrid System Technology.	• Introduction to Hybrid Power Generation. • Description of Hybrid System. • Solar/Wind/Diesel System. • Hybrid Control. • Monitoring Systems. • Diesel Power Plant Working Principle.	14	2
11.	Project Cost Estimation and Economic Analysis.	• Learning Objectives. • Cost Estimation. • Cost Management Plan. • Cost Concepts. • Costs of Solar Process Systems. • Uncertainties in Economic Analysis. • Payback Period.	15	2
12.	Final Exam	• All the Chapters.	16	2
Number of Weeks /and Units Per Semester			**16**	**32**

B- Tutorial Aspect:-

Order	Tasks/ Experiments	Number of Weeks	Contact hours	Learning Outcomes
1.	Solar Energy Utilization.	1,2	4	a1, b1, b2, d1, d2.
2.	Flat Plate Collectors (Liquid and Air Heaters).	3,4	4	a1, a2, b1, b2, b3, c1, d1, d2, d3.
3.	Concentrating Collector.	5	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
4.	Photovoltaic System.	6	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
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6.	Hydro Power Technology.	9,10	4	a1, a2, b1, b2, b3, c1, d1, d2, d3.
7.	Geothermal Energy Technology.	11	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
8.	Biomass, Wave and Tidal Technology.	12	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
9.	Hybrid System Technology.	13	2	a1, a2, b1, b2, b3, c1, d1, d2, d3.
10.	Project Cost Estimation and Economic Analysis.	14	2	a1, a2,b1, b2, b3, c1, c2, d1, d2, d3.
Number of Weeks /and Units Per Semester: 14			**28**	

VI.Teaching strategies of the course:

- Active Lectures.
- Tutorials.
- The use of Computer and Web-Based Learning.
- Design Work and Project.
- Case Studies.
- Independent Learning.
- Directed Self Study.
- Group Learning and Problem Based Learning.

VII.Assignments:

No	Assignments	Aligned CILOs (symbols)	Week Due	Mark
1.	Tutorials (Chapter 1- Chapter 10).	a1, b1, b2, d1, d2.	1-14	20
Total				**20**

VIII.Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1.	Assessment (Work Sample such as Portfolios).	1-14	20	13.33 %
2.	Mid-Term Exam.	9	25	16.67 %
3.	Final Exam.	16	105	70 %
Total			**150**	**100%**

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IX.Learning Resources:

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2- Essential References.

1. John A. Duffy and William A. Beckman, 1980, Solar Engineering of Thermal Processe Second Edition, John Wiley & Sons Inc.

3- Electronic Materials and Web Sites *etc*.

1. www.environmentalsciencedegree.com.
2. www.irena.org.
3. www.renewable-technology.com.

X.Course Policies:

Unless otherwise stated, the normal course administration policies and rules of the Faculty of Engineering apply. For the policy, see: ----------

.1	**Class Attendance:** - The students should have more than 75% of attendance according to rules and regulations of the faculty.
.2	**Tardy:** - The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture.
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