8- Course Specification of Renewable Energy and Applications
Course Code (ME526)

• General Information About the Course:

1.	Course Title:	Renewable Energy and Applications.			
2.	Course Code and Number:	ME526.			
3.	Credit Hours:	Contact Hours			Total (Credit Hours)
		Lecture	Practical	Seminar/Tutorial	
		2	-	2	3
4.	Study Level and Semester:	First Semester.			
5.	Pre-requisites (if any):	Heat and Mass Transfer and Advanced Energy Conversion.			
6.	Co-requisites (if any):	-			
7.	Program (s) in which the course is offered:	MSc. In Mechanical Engineering Program.			
8.	Language of teaching the course:	English Language.			
9.	Study System:	Courses & Thesis.			
10.	Prepared By:	Assoc. Prof. Dr. Abdul-Malik E. Momin.			
11.	Reviewed by:	Dr. ……			
12.	Date of Approval:				

• Course Description:

Renewable energy can be defined as energy generated from natural sources. This course will give an overview of the main scientific principles and technologies related to harnessing and conversion of the earth´s renewable energy sources, combined with a wide range of case studies. Renewable energy technologies generally have fewer environmental and health impacts than non-renewables. This course a Master Program in renewable energy is a postgraduate degree program whose aim is to help in meeting challenges facing the world today- production of renewable energy.

The program will extend your skills into several technologies in renewable energy such as Solar, Hydro, Wind, Tidal and Biomass just to mention a few. As well as, it focuses on the practical application of renewable energy technologies. Students will study the advantages, limitations and potential of various energy sources. This course informs and engages students to be thoughtful, rather than passive, consumers of energy. Students gain the knowledge necessary to be articulate in career, community, and personal arenas regarding renewable energy resources.

• Course Intended Learning Outcomes (CILOs):

Upon successful completion of **Renewable Energy and Applications Course**, the graduates will be able to:

a1- Illustrate the basic knowledge of engineering sciences subjects concerning the Renewable Energy**.**

a2 - Describe the different trends and developments within the thermal engineering contexts.

a3- Classify concepts and techniques to design thermal systems with sustainable and environmentally friendly approach.

b1 - Integrate knowledge and skills to solve critical problems in the system.
b2- Explore different tools to solve complex engineering problems.
b3- Formulate thermal components to meet the actual needs.
b4- Examine risks of the professional practice.
c1- Demonstrate different manufacturing processes for the actual design of the thermal components.
c2- Perform research to solve thermal engineering problems within the constraints.
c3 - Prescribe different understanding to reach to modern operations and business management in the applications of the Renewable Energy.
d1- Review IT capabilities and other resources to develop a scientific research in Renewable System**.**
d2- Justify in both orally and writing forms for different audiences.
d3- Assess latest knowledge for life-long learning in the area of the Renewable Energy.
d4- Cooperate effectively in teams to reach to a professional context.

• Alignment of Course Intended Learning Outcomes (CILOs) to Program Intended Learning Outcomes (PILOs)

CILOs		PILOs	
• **Knowledge and Understanding:** Upon successful completion of the Advance Energy Conversion **Course**, the graduates will be able to:		• **Knowledge and Understanding:** Upon successful completion of the **MSc. In Mechanical Engineering Program**, the graduates will be able to:	
a1.	Illustrate the basic knowledge of engineering sciences subjects concerning the Renewable Energy.	**A1.**	Acquire advanced concepts and knowledge of mathematics, scientific, mechanical engineering and associated technologies as well as across the boundaries of interdisciplinary disciplines.
a2.	Describe the different trends and developments within the thermal engineering contexts.	**A2.**	Identify and critically evaluate contemporary engineering technologies, current developments and emerging trends within the mechanical engineering contexts.
a3.	Classify concepts and techniques to design thermal systems with sustainable and environmentally friendly approach.	**A3.**	Provide a holistic description of principles, concepts, approaches, techniques and analysis tools to design and development of existing and novel mechanical systems, while taking a sustainable and environmentally-friendly approach.
• **Cognitive/ Intellectual Skills:** Upon successful completion of the Advance Energy Conversion **Course,** the graduates will be able to:		• **Cognitive/ Intellectual Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:	
b1.	Integrate knowledge and skills to solve	**B1.**	Identify and apply specialized

	critical problems in the system.		knowledge and skills to solve problems that are critical to future growth of industry and business.
b2.	Explore different tools to solve complex engineering problems. .	**B2.**	Creatively thinking and apply analysis tools to formulate and solve complex engineering problems in the mechanical engineering context using modern techniques and tools.
b3.	Formulate thermal components to meet the actual needs	**B3.**	Design and optimize mechanical components, systems and process to meet desired needs within realistic constraints.
b4.	Examine risks of the professional practice.	**B4.**	Analyze and assess risks of the professional practice in the mechanical engineering contexts.
• **Professional and Practical Skills:** Upon successful completion of the Advance Energy Conversion **Course,** the graduates will be able to:		• **Professional and Practical Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:	
c1.	Demonstrate different manufacturing processes for the actual design of the thermal components.	**C1.**	Use modern manufacturing processes and materials, experimental tests, appropriate software packages and other modern tools for the design analysis and manufacture of mechanical components and systems.
c2.	Perform research to solve thermal engineering problems within the constraints.	**C2.**	Conduct research and studies to solve mechanical engineering problems professionally, ethically and responsibly within realistic constraints.
c3.	Prescribe different understanding to reach to modern operations and business management in the applications of the Renewable Energy.	**C3.**	Demonstrate an in-depth understanding of the mechanical engineering business environment, including environmental aspects, and apply quality issues, modern operations and business management techniques and good practices in a range of contexts.
• **Transferable Skills:** Upon successful completion of the Advance Energy Conversion **Course,** the graduates will be able to:		• **Transferable Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:	
d1.	Review IT capabilities and other resources to develop a scientific research in Renewable System.	**D1.**	Adopt effectively IT capabilities and other different resources of information to develop a scientific research in mechanical engineering fields.
d2.	Justify in both orally and writing forms for different audiences.	**D2.**	Communicate, present, challenge and defend research ideas, results and conclusions in both orally and writing forms to different audiences in

			contexts.
d3.	Assess latest knowledge for life-long learning in the area of the Renewable Energy.	**D3.**	Identify a need for the latest relevant knowledge and technologies and undertake life-long learning.
d4.	Cooperate effectively in teams to reach to a professional context.	**D4.**	Collaborate effectively within multidisciplinary teams and lead them in different professional contexts

• Alignment of CILOs to Teaching and Assessment Strategies

• Alignment of Knowledge and Understanding CILOs:

Knowledge and Understanding CILOs		Teaching Strategies	Assessment Strategies
a1.	Illustrate the basic knowledge of engineering sciences subjects concerning the Renewable Energy.	▪ Lectures, ▪ Seminars, ▪ Self-Learning Problems/Studies, ▪ Case study, ▪ Group/Individual Projects and Studies, ▪ Field Work ▪ Active learning, ▪ Computer hands-on sessions.	▪ Oral & Written Exams. ▪ Reports, ▪ Survey, ▪ Written Exam, ▪ Assignments
a2.	Describe the different trends and developments within the thermal engineering contexts.	▪ Lectures, ▪ Seminars, ▪ Self-Learning Problems/Studies, ▪ Case study, ▪ Group/Individual Projects and Studies, ▪ Field Work ▪ Active learning, ▪ Computer hands-on sessions.	▪ Oral & Written Exams ▪ Reports, ▪ Survey, ▪ Written Exam, ▪ Assignments.
a3.	Classify concepts and techniques to design thermal systems with sustainable and environmentally friendly approach**.**	▪ Lectures, ▪ Seminars, ▪ Self-Learning Problems/Studies, ▪ Case study, ▪ Group/Individual Projects and Studies, ▪ Field Work ▪ Active learning, ▪ Computer hands-on sessions.	▪ Oral & Written Exams. ▪ Reports, ▪ Survey, ▪ Written Exam, ▪ Assignments.

• Alignment of Intellectual Skills CILOs:

Intellectual Skills CILOs		Teaching Strategies	Assessment Strategies
b1.	Integrate knowledge and skills to solve critical problems in the system.	▪ Lectures, ▪ Project Supervision, ▪ Self-Learning, ▪ Case Study, ▪ Simulation Exercises,	▪ Oral & Written Exams, ▪ Reports, ▪ Report, ▪ Survey,

		▪ Independent Study, ▪ Analysis and Problem Solving, ▪ Brainstorming, ▪ Presentations.	▪ Written Exam, ▪ Assignments.
b2.	Formulate thermal components to meet the actual needs**.**	▪ Lectures, ▪ Project Supervision, ▪ Self-Learning, ▪ Case Study, ▪ Simulation Exercises, ▪ Independent Study, ▪ Analysis and Problem Solving, ▪ Brainstorming, ▪ Presentations.	▪ Oral & Written Exams, ▪ Reports, ▪ Report, ▪ Survey, ▪ Written Exam, ▪ Assignments.
b3.	Formulate mechanical components to meet the actual needs.	▪ Lectures, ▪ Project Supervision, ▪ Self-Learning, ▪ Case Study, ▪ Simulation Exercises, ▪ Independent Study, ▪ Analysis and Problem Solving, ▪ Brainstorming, ▪ Presentations.	▪ Oral & Written Exams, ▪ Reports, ▪ Report, ▪ Survey, ▪ Written Exam, ▪ Assignments.
b4.	Examine risks of the professional practice.	▪ Lectures, ▪ Project Supervision, ▪ Self-Learning, ▪ Case Study, ▪ Simulation Exercises, ▪ Independent Study, ▪ Analysis and Problem Solving, ▪ Brainstorming, ▪ Presentations.	▪ Oral & Written Exams, ▪ Reports, ▪ Report, ▪ Survey, ▪ Written Exam, ▪ Assignments.

- **Alignment of Professional and Practical Skills CILOs:**

Professional and Practical Skills CILOs		Teaching Strategies	Assessment Strategies
c1.	Demonstrate different manufacturing processes for the actual design of the thermal components.	▪ Lectures, ▪ Project Supervision, ▪ Self-Learning, ▪ Case Study, ▪ Simulation Exercises, ▪ Independent Study, ▪ Analysis and Problem Solving, ▪ Brainstorming, ▪ Presentations.	▪ Seminar Report, ▪ Written Research Proposal, ▪ Thesis and Publication.
c2.	Perform research to solve thermal engineering problems within the	▪ Lectures, ▪ Project Supervision,	▪ Seminar Report, ▪ Written Research

	constraints.	▪ Self-Learning, ▪ Case Study, ▪ Simulation Exercises, ▪ Independent Study, ▪ Analysis and Problem Solving, ▪ Brainstorming, ▪ Presentations.	Proposal, ▪ Thesis and Publication.
c3.	Prescribe different understanding to reach to modern operations and business management in the applications of the Renewable Energy.	▪ Lectures, ▪ Project Supervision, ▪ Self-Learning, ▪ Case Study, ▪ Simulation Exercises, ▪ Independent Study, ▪ Analysis and Problem Solving, ▪ Brainstorming, ▪ Presentations.	▪ Seminar Report, ▪ Written Research Proposal, ▪ Thesis and Publication.

- **Alignment of Transferable (General) Skills CILOs:**

Transferable (General) Skills CILOs		Teaching Strategies	Assessment Strategies
d1.	Review IT capabilities and other resources to develop a scientific research in Renewable System.	▪ Dissertation Defenses and Presentation, ▪ Independent Study, ▪ Presentation, ▪ Brainstorming, ▪ Presenting Researches, ▪ Publish Research Papers.	▪ Written Research Proposal, Thesis and Publication, ▪ Written Exam, ▪ Assignments, ▪ Field Work, ▪ Survey, ▪ Presentation, ▪ Written Report.
d2.	Justify in both orally and writing forms for different audiences. .	▪ Dissertation Defenses and Presentation, ▪ Independent Study, ▪ Presentation, ▪ Brainstorming, ▪ Presenting Researches, ▪ Publish Research Papers.	▪ Written Research Proposal, Thesis and Publication, ▪ Written Exam, ▪ Assignments, ▪ Field Work, ▪ Survey, ▪ Presentation, ▪ Written Report.
d3.	Assess latest knowledge for life-long learning in the area of the Renewable Energy.	▪ Dissertation Defenses and Presentation, ▪ Independent Study, ▪ Presentation, ▪ Brainstorming, ▪ Presenting Researches, ▪ Publish Research Papers.	▪ Written Research Proposal, Thesis and Publication, ▪ Written Exam, ▪ Assignments, ▪ Field Work, ▪ Survey, ▪ Presentation, ▪ Written Report.
d4.	Cooperate effectively in teams to reach to a professional contexts.	▪ Dissertation Defenses and Presentation,	▪ Written Research Proposal, Thesis and

		▪ Independent Study, ▪ Presentation, ▪ Brainstorming, ▪ Presenting Researches, ▪ Publish Research Papers.	Publication, ▪ Written Exam, ▪ Assignments, ▪ Field Work, ▪ Survey, ▪ Presentation, ▪ Written Report.

• Course Content

1.Theoretical Aspect

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course CILOs
1.	Introduction to Renewable Energy.	▪ Introduction. ▪ Advanced Concept for the Renewable Energy. ▪ Energy Solution. ▪ Sustainability. ▪ Green Technology.	1	2	a1, a2, b1, b2,b3, d1, d3, d4
2.	Solar Radiations.	▪ Introduction. ▪ Electro- magnetic spectrum. ▪ Beam Radiations. ▪ Diffuse Radiations. ▪ Solar Constant. ▪ Tilted Surfaces. ▪ Pyranometers and Pyrheliometers. ▪ Solar Radiation Data. ▪ Estimation of Average Solar Radiations.	2	4	a1, a2, a3, b1, b2,b3, c1, c3, d1, d3, d4
3.	Selected Heat Transfer Topics.	▪ The Black Body. ▪ Radiation Heat Transfer Coefficient. ▪ Natural Convection between Flat Parallel Plates and between Concentric Cylinders. ▪ Heat Transfer Relations for Internal Flow.	2	4	a1, a2, a3, b1, b2,b3, c1, c3, d1, d3, d4
4.	Types of Collectors, Flat Plate and Concentrating Collectors.	▪ Description of Flat Plate Collectors. ▪ Basic Flat Plate Energy Balance Equation. ▪ Collector Overall Heat Loss Coefficient. ▪ Collector Heat Removal Factor and Flow Factor. ▪ Description of Concentrating Collectors. ▪ Concentration Ratio. ▪ Thermal Performance of Concentrating Collectors. ▪ Practical Considerations.	2	4	a2, a3, b1, b2,b3, b4, c1, c2, d3, d4
5.	Photovoltaic Systems.	▪ Photovoltaic Converters. ▪ Cells Temperature. ▪ Solar Technology (Safety). ▪ Characteristics of Photovoltaic Solar Cell. ▪ Commercial Solar Cells. ▪ Typical PV System.	1	2	a2, a3. b1, b3, b4, c1, c2, d3, d4

• Course Content

1.Theoretical Aspect

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course CILOs
6.	Mid-Term Exam	▪ The First Five Chapters.	1	2	a1, a2, a3. b1, b2, b3, b4, c1, c2, c3, d1, d3
7.	Solar Thermal Power Systems.	▪ Thermal Conversion Systems. ▪ Solar Power Plant.	1	2	a2, a3. b1, b3, b4, c1, c2, d3, d4
8.	Introduction to Wind Energy Systems and Design of Wind Energy Systems	▪ Introduction. ▪ Types of Wind Turbines. ▪ Wind Resources. ▪ Wind Turbine Model. ▪ Estimation of Wind Turbine Average Power and Energy Production.	1	2	a1, a2, a3. b1, b2, b3, b4, c1, c2, c3, d1, d3, d4
9.	Solar Ponds: Evaporative Processes.	▪ Pond Theory. ▪ Solar Distillation. ▪ Direct Solar Drying.	1	2	a2, a3. b1, b3, b4, c1, c2, d3, d4
10.	Geothermal Energy.	▪ Introduction and the Earth Structure. ▪ Geothermal Reservoir. ▪ Geothermal Exploration Surveys. ▪ Deep Well Drill. ▪ Dry Steam Power Plant. ▪ Benefits of Geothermal Processes.	1	2	a1, a3, b1, b3, b4, c2, c3, d1, d2, d3, d4
11.	Hydraulic Energy.	▪ Types of Turbines and their Classifications. ▪ Turbine Selection. ▪ Description of Typical Power Plants. ▪ Energy Conversion in Hydro Power Plants. ▪ Turbine Design and Erection.	1	2	a1, a3, b1, b3, b4, c2, c3, d1, d2, d3, d4
12.	Energy Conversion and Efficiency, Energy Economics and Management.	▪ Energy Conversion Efficiency. ▪ Energy Efficiency. ▪ Economics Methods. ▪ Industrial Energy Efficiency and Energy Management. ▪ Energy and Environmental Impact.	1	2	a1, a2, a3. b1, b2, b3, b4, c1, c2, c3, d1, d2, d3, d4
13.	The Final Exam.	▪ All the Chapters.	1	3	a1, a2, a3. b1, b2, b3, b4, c1, c2,

• Course Content

1.Theoretical Aspect

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course CILOs
					c3, d1, d3
Number of Weeks /and Contact Hours Per Semester			**16**	**33**	

- **2.Practical Aspect**

Order	Practical / Tutorials topics (None)	Number of Weeks	Contact Hours	Course ILOs
1	▪			
2	▪ ▪			
3	▪ ▪			
4	•			
5	▪			
6	• ▪			
Number of Weeks /and Contact Hours Per Semester				

3.Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1.	Solar Radiations.	2	4	a1, a2, a3, b1, b2,b3, c1, c3, d1, d3, d4
2.	Selected Heat Transfer Topics.	2	4	a1, a2, a3, b1, b2,b3, c1, c3, d1, d3, d4
3.	Types of Collectors, Flat Plate and Concentrating Collectors.	2	4	a2, a3, b1, b2,b3, b4, c1, c2, d3, d4
4.	Introduction to Wind Energy Systems and Design of Wind Energy Systems.	2	4	a1, a2, a3. b1, b2, b3, b4, c1, c2, c3, d1, d3, d4
5.	Solar Ponds: Evaporative Processes.	2	4	a2, a3. b1, b3, b4, c1, c2, d3, d4
6.	Hydraulic Energy.	2	4	a1, a3, b1, b3, b4, c2, c3, d1, d2, d3, d4
7.	Energy Conversion and Efficiency, Energy Economics and Management.	2	4	a1, a2, a3. b1, b2, b3, b4, c1, c2, c3, d1, d2, d3, d4
Number of Weeks /and Units Per Semester		14	28	

• Teaching Strategies:

- Lectures.
- Seminars.
- Group/ Individual Projects and Studies.
- Field Work.
- Computer Hands-on Session.
- Simulation Exercise.
- Analysis and Problem Solving.
- Dissertation Defenses and Presentation.
- Publish Research Papers.

• Assessment Methods of the Course:

- Oral and Written Exams.
- Reports.
- Assignments.
- Seminar Report.
- Written Research Proposal.
- Thesis and Publication.
- Field Work.
- Presentation.
- Written Report.

• Tasks and Assignments:

No	Assignments/ Tasks	Individual/ Group	Mark	Week Due	CILOs (symbols)
1.	Homework and Assignments.	Individual	15	Every Week	a1, a2, a3, b1, b2, b3, b4, c1, c2, c3, d1, d2, d3, d4
2.	Mini/Major Project (Thesis).	Group	40	At the End of the Semester	a1, a2, a3, b1, b2, b3, b4, c1, c2, c3, d1, d2, d3, d4
3.	Case studies.	-	-	-	-
	Total Score		**55**	==	===

• Learning Assessment:

No.	Assessment Tasks	Week due	Mark	Proportion of Final Assessment	CILOs
1.	Tasks and Assignments.	Every Week	55	55	a1, a2, a3, b1, b2, b3, b4, c1, c2, c3, d1, d2, d3, d4
2.	Quizzes (4 quizzes).	Every 3 weeks	10	10	a1, a2, a3, b1, b2, b3, b4, c1, c2, c3, d1, d2, d3, d4
3.	Mid-Term Exam.	Sixth Week	10	10	a1, a2, a3. b1, b2, b3, b4, c1, c2, c3, d1, d3
4.	Final Exam (Practical).	-	-	-	-
5.	Final Exam (Theoretical).	Last Week (Week No. 16)	25	25	a1, a2, a3. b1, b2, b3, b4, c1, c2, c3, d1, d3
Total				**100%**	**===**

• Learning Resources :

1. Required Textbook(s) :

1. Jaume Salom, Thorsten Urbaneck and Eduard Oro , "Advanced Concepts for Renewable Energy Supply of Data Centres", River Publishers, 2017.
2. Hermod Brekke, "Hydraulic Turbines Design, Erection, and Operation, Endringsdato, 2001.
3. D. Yogi Goswami and Frank Kreith, "Energy Efficiency and Renewable Energy Hand Book", Taylor & Francis Group, 2016.
4. B H Khan, "Non-Conventional Energy Resources", McGraw Hill, 2006.

2. Essential References:

1. John A. Duffie and William A. Beckman, "Solar Engineering of Thermal Processes", Fourth Edition, John Wiley & Sons Inc., 2013.

2. Yunus A. Cengel, Mehmet Kanoglu and John M. Cimbala, " Fundamentals and Applications of Renewable Energy", McGraw Hill Education, 2020.

3. Electronic Materials and Web Sites *etc.*

1.

2.

• **الضوابط والسياسات المتبعة في المقرر Course Policies**	
بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:	
1	**سياسة حضور الفعاليات التعليمية Class Attendance:** **- يلتزم الطالب بحضور 75% من المحاضرات ويحرم في حال عدم الوفاء بذلك.** **- يقدم أستاذ المقرر تقريرا بحضور وغياب الطلاب للقسم ويحرم الطالب من دخول الامتحان في حال تجاوز الغياب 25% ويتم اقرار الحرمان من مجلس القسم.**
2	**الحضور المتأخر Tardy:** **- يسمح للطالب حضور المحاضرة إذا تأخر لمدة ربع ساعة لثلاث مرات في الفصل الدراسي، وإذا تأخر زيادة عن ثلاث مرات يحذر شفويا من أستاذ المقرر، وعند عدم الالتزام يمنع من دخول المحاضرة.**
3	**ضوابط الامتحان Exam Attendance/Punctuality:** **- لا يسمح للطالب دخول الامتحان النهائي إذا تأخر مقدار (20) دقيقة من بدء الامتحان** **- إذا تغيب الطالب عن الامتحان النهائي تطبق اللوائح الخاصة بنظام الامتحان في الكلية.**
4	**التعيينات والمشاريع Assignments & Projects:** **- يحدد أستاذ المقرر نوع التعيينات في بداية الفصل ويحدد مواعيد تسليمها وضوابط تنفيذ التكليفات وتسليمها.** **- إذا تأخر الطالب في تسليم التكليفات عن الموعد المحدد يحرم من درجة التكليف الذي تأخر في تسليمه.**
5	**الغش Cheating:** **- في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب.** **- في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف.**
6	**الانتحال Plagiarism:** **– في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك**
7	**سياسات أخرى Other policies:** **- أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات ..... الخ**

Academic Year:2021/2022

Course Plan of Renewable Energy and Applications

Course Code (ME526)

• Information about Faculty Member Responsible for the Course:

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

• General information about the course:

	Course Title	Renewable Energy and Applications.			
2.	Course Code and Number	ME526.			
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		Lecture	Practical	Seminar/Tutorial	
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4.	Study Level and Semester	First Semester.			
5.	Pre-requisites	Heat and Mass Transfer and Renewable Energy Systems.			
6.	Co –requisite	-			
7.	Program (s) in which the course is offered	MSc. In Mechanical Engineering Program.			
8.	Language of teaching the course	English Language.			
9.	Location of teaching the course	Faculty of Engineering, Mechanical Engineering Department.			

• Course Description:

Renewable energy can be defined as energy generated from natural sources. This course will give an overview of the main scientific principles and technologies related to harnessing and conversion of the earth´s renewable energy sources, combined with a wide range of case studies. Renewable energy technologies generally have fewer environmental and health impacts than non-renewables. This course a Master Program in renewable energy is a postgraduate degree program whose aim is to help in meeting challenges facing the world today- production of renewable energy.

The program will extend your skills into several technologies in renewable energy such as Solar, Hydro, Wind, Tidal and Biomass just to mention a few. As well as, it focuses on the practical application of renewable energy technologies. Students will study the advantages, limitations and potential of various energy sources. This course informs and engages students to be thoughtful, rather than passive, consumers of energy. Students gain the knowledge necessary to be articulate in career, community, and personal arenas regarding renewable energy resources.

• Course Intended Learning Outcomes (CILOs):

Upon successful completion of the **Renewable Energy and Applications** course, graduate students will be able to:

a1- Illustrate the basic knowledge of engineering sciences subjects concerning the Renewable Energy**.**
a2 - Describe the different trends and developments within the thermal engineering contexts.
a3- Classify concepts and techniques to design thermal systems with sustainable and environmentally friendly approach.
b1 - Integrate knowledge and skills to solve critical problems in the system.
b2- Explore different tools to solve complex engineering problems.
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b4- Examine risks of the professional practice.
c1- Demonstrate different manufacturing processes for the actual design of the thermal components.
c2- Perform research to solve thermal engineering problems within the constraints.
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d2- Justify in both orally and writing forms for different audiences.
d3- Assess latest knowledge for life-long learning in the area of the Renewable Energy.
d4- Cooperate effectively in teams to reach to a professional context.

V.Alignment of Course Intended Learning Outcomes (CILOs) to Program Intended Learning Outcomes (PILOs)

CILOs	PILOs

a.Knowledge and Understanding: Upon successful completion of the Advance Energy Conversion **Course**, the graduates will be able to:		**A.Knowledge and Understanding:** Upon successful completion of the **MSc. In Mechanical Engineering Program**, the graduates will be able to:	
a1.	Illustrate the basic knowledge of engineering sciences subjects concerning the Renewable Energy**.**	**A1.**	Acquire advanced concepts and knowledge of mathematics, scientific, mechanical engineering and associated technologies as well as across the boundaries of interdisciplinary disciplines.
a2.	Describe the different trends and developments within the thermal engineering contexts.	**A2.**	Identify and critically evaluate contemporary engineering technologies, current developments and emerging trends within the mechanical engineering contexts.
a3.	Classify concepts and techniques to design thermal systems with sustainable and environmentally friendly approach.	**A3.**	Provide a holistic description of principles, concepts, approaches, techniques and analysis tools to design and development of existing and novel mechanical systems, while taking a sustainable and environmentally-friendly approach.
b.Cognitive/ Intellectual Skills: Upon successful completion of the Advance Energy Conversion **Course,** the graduates will be able to:		**B.Cognitive/ Intellectual Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:	
b1.	Integrate knowledge and skills to solve critical problems in the system.	**B1.**	Identify and apply specialized knowledge and skills to solve problems that are critical to future growth of industry and business.
b2.	Explore different tools to solve complex engineering problems.	**B2.**	Creatively thinking and apply analysis tools to formulate and solve complex engineering problems in the mechanical engineering context using modern techniques and tools.
b3.	Formulate thermal components to meet the actual needs.	**B3.**	Design and optimize mechanical components, systems and process to meet desired needs within realistic constraints.
b4.	Examine risks of the professional practice.	**B4.**	Analyze and assess risks of the professional practice in the mechanical engineering contexts.
c.Professional and Practical Skills: Upon successful completion of the Advance Energy Conversion **Course,** the graduates will be able to:		**C.Professional and Practical Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:	
c1.	Demonstrate different manufacturing processes for the actual design of the thermal components.	**C1.**	Use modern manufacturing processes and materials, experimental tests, appropriate software packages and

			other modern tools for the design analysis and manufacture of mechanical components and systems.
c2.	Perform research to solve thermal engineering problems within the constraints	**C2.**	Conduct research and studies to solve mechanical engineering problems professionally, ethically and responsibly within realistic constraints.
c3.	Prescribe different understanding to reach to modern operations and business management in the applications of the Renewable Energy.	**C3.**	Demonstrate an in-depth understanding of the mechanical engineering business environment, including environmental aspects, and apply quality issues, modern operations and business management techniques and good practices in a range of contexts.
d.Transferable Skills: Upon successful completion of the Advance Energy Conversion **Course,** the graduates will be able to:		**D.Transferable Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:	
d1.	Review IT capabilities and other resources to develop a scientific research in Renewable System.	**D1.**	Adopt effectively IT capabilities and other different resources of information to develop a scientific research in mechanical engineering fields.
d2.	Justify in both orally and writing forms for different audiences.	**D2.**	Communicate, present, challenge and defend research ideas, results and conclusions in both orally and writing forms to different audiences in contexts.
d3.	Assess latest knowledge for life-long learning in the area of the Renewable Energy.	**D3.**	Identify a need for the latest relevant knowledge and technologies and undertake life-long learning.
d4.	Cooperate effectively in teams to reach to a professional contexts.	**D4.**	Collaborate effectively within multidisciplinary teams and lead them in different professional contexts

VI.Course Content

1.Theoretical Aspect

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours
1.	Introduction to Renewable Energy.	▪ Introduction. ▪ Advanced Concept for the Renewable Energy. ▪ Energy Solution. ▪ Sustainability. ▪ Green Technology.	1	2

2.	Solar Radiations.	▪ Introduction. ▪ Electro- magnetic spectrum. ▪ Beam Radiations. ▪ Diffuse Radiations. ▪ Solar Constant. ▪ Tilted Surfaces. ▪ Pyranometers and Pyrheliometers. ▪ Solar Radiation Data. ▪ Estimation of Average Solar Radiations.	2	4
3.	Selected Heat Transfer Topics.	▪ The Black Body. ▪ Radiation Heat Transfer Coefficient. ▪ Natural Convection between Flat Parallel Plates and between Concentric Cylinders. ▪ Heat Transfer Relations for Internal Flow.	2	4
4.	Types of Collectors, Flat Plate and Concentrating Collectors.	▪ Description of Flat Plate Collectors. ▪ Basic Flat Plate Energy Balance Equation. ▪ Collector Overall Heat Loss Coefficient. ▪ Collector Heat Removal Factor and Flow Factor. ▪ Description of Concentrating Collectors. ▪ Concentration Ratio. ▪ Thermal Performance of Concentrating Collectors. ▪ Practical Considerations.	2	4
5.	Photovoltaic Systems.	▪ Photovoltaic Converters. ▪ Cells Temperature. ▪ Solar Technology (Safety). ▪ Characteristics of Photovoltaic Solar Cell. ▪ Commercial Solar Cells. ▪ Typical PV System.	1	2
6.	Mid-Term Exam	▪ The First Five Chapters.	1	2
7.	Solar Thermal Power Systems.	▪ Thermal Conversion Systems. ▪ Solar Power Plant.	1	2
8.	Introduction to Wind Energy Systems and Design of Wind Energy Systems	▪ Introduction. ▪ Types of Wind Turbines. ▪ Wind Resources. ▪ Wind Turbine Model. ▪ Estimation of Wind Turbine Average Power and Energy Production.	1	2

9.	Solar Ponds: Evaporative Processes.	▪ Pond Theory. ▪ Solar Distillation. ▪ Direct Solar Drying.	1	2
10.	Geothermal Energy.	▪ Introduction and the Earth Structure. ▪ Geothermal Reservoir. ▪ Geothermal Exploration Surveys. ▪ Deep Well Drill. ▪ Dry Steam Power Plant. ▪ Benefits of Geothermal Processes.	1	2
11.	Hydraulic Energy.	▪ Types of Turbines and their Classifications. ▪ Turbine Selection. ▪ Description of Typical Power Plants. ▪ Energy Conversion in Hydro Power Plants. ▪ Turbine Design and Erection.	1	2
12.	Energy Conversion and Efficiency, Energy Economics and Management.	▪ Energy Conversion Efficiency. ▪ Energy Efficiency. ▪ Economics Methods. ▪ Industrial Energy Efficiency and Energy Management. ▪ Energy and Environmental Impact.	1	2
13.	The Final Exam.	▪ All the Chapters.	1	3
Number of Weeks /and Contact Hours Per Semester			**16**	**33**

2.Practical Aspect				
Order	**Practical / Tutorials topics (None)**	**Number of Weeks**	**Contact Hours**	**Course ILOs**
1	▪			
2	▪ ▪			
3	▪ ▪			
4	•			
5	▪			
6	• ▪			
Number of Weeks /and Contact Hours Per Semester				

3.Tutorial Aspect:			
No.	**Tutorial**	**Number of Weeks**	**Contact Hours**
1.	Solar Radiations.	2	4
2.	Selected Heat Transfer Topics.	2	4
3.	Types of Collectors, Flat Plate and Concentrating Collectors.	2	4
4.	Introduction to Wind Energy Systems and Design of Wind Energy Systems.	2	4
5.	Solar Ponds: Evaporative Processes.	2	4
6.	Hydraulic Energy.	2	4
7.	Energy Conversion and Efficiency, Energy Economics and Management.	2	4
Number of Weeks /and Units Per Semester		14	28

VII.Teaching Strategies:

- Lectures.
- Seminars.
- Group/ Individual Projects and Studies.
- Field Work.
- Computer Hands-on Session.
- Simulation Exercise.
- Analysis and Problem Solving.
- Dissertation Defenses and Presentation.
- Publish Research Papers.

IX. Assessment Methods of the Course:

- Oral and Written Exams.
- Reports.
- Assignments.
- Seminar Report.
- Written Research Proposal.
- Thesis and Publication.
- Field Work.
- Presentation.
- Written Report.

IX.Tasks and Assignments:

No	Assignments/ Tasks	Individual/ Group	Mark	Week Due
1.	Homework and Assignments.	Individual	15	Every Week
2.	Mini/Major Project (Thesis).	Group	40	At the End of the Semester
3.	Case studies.	-	-	-
4.				
	Total Score		**55**	==

X.Learning Assessment:

No.	Assessment Tasks	Week due	Mark	Proportion of Final Assessment
1.	Tasks and Assignments.	Every Week	55	55
2.	Quizzes (4 quizzes).	Every 3 weeks	10	10

3.	Mid-Term Exam.	Sixth Week	10	10
4.	Final Exam (Practical).	-	-	-
5.	Final Exam (Theoretical).	Last Week (Week No. 16)	25	25
Total				**100%**

XI.Learning Resources :

1.Required Textbook(s) :

1. Jaume Salom, Thorsten Urbaneck and Eduard Oro , "Advanced Concepts for Renewable Energy Supply of Data Centres", River Publishers, 2017.
2. Hermod Brekke, "Hydraulic Turbines Design, Erection, and Operation, Endringsdato, 2001.
3. D. Yogi Goswami and Frank Kreith, "Energy Efficiency and Renewable Energy Hand Book", Taylor & Francis Group, 2016.
4. B H Khan, "Non-Conventional Energy Resources", McGraw Hill, 2006.

2,Essential References:

1. John A. Duffie and William A. Beckman, "Solar Engineering of Thermal Processes", Fourth Edition, John Wiley & Sons Inc., 2013.
2. Yunus A. Cengel, Mehmet Kanoglu and John M. Cimbala, " Fundamentals and Applications of Renewable Energy", McGraw Hill Education, 2020.

3.Electronic Materials and Web Sites *etc.*

1.

- **الضوابط والسياسات المتبعة في المقرر Course Policies**

بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:

1	**سياسة حضور الفعاليات التعليمية Class Attendance:** **- يلتزم الطالب بحضور 75% من المحاضرات ويحرم في حال عدم الوفاء بذلك.** **- يقدم أستاذ المقرر تقريرا بحضور وغياب الطلاب للقسم ويحرم الطالب من دخول الامتحان في حال تجاوز الغياب 25% ويتم اقرار الحرمان من مجلس القسم.**
2	**الحضور المتأخر Tardy:** **- يسمح للطالب حضور المحاضرة إذا تأخر لمدة ربع ساعة لثلاث مرات في الفصل الدراسي، وإذا تأخر زيادة عن ثلاث مرات يحذر شفويا من أستاذ المقرر، وعند عدم الالتزام يمنع من دخول المحاضرة.**
3	**ضوابط الامتحان Exam Attendance/Punctuality:** **- لا يسمح للطالب دخول الامتحان النهائي إذا تأخر مقدار (20) دقيقة من بدء الامتحان** **- إذا تغيب الطالب عن الامتحان النهائي تطبق اللوائح الخاصة بنظام الامتحان في الكلية.**
4	**التعيينات والمشاريع Assignments & Projects:** **- يحدد أستاذ المقرر نوع التعيينات في بداية الفصل ويحدد مواعيد تسليمها وضوابط تنفيذ التكليفات وتسليمها.** **- إذا تأخر الطالب في تسليم التكليفات عن الموعد المحدد يحرم من درجة التكليف الذي تأخر في تسليمه.**
5	**الغش Cheating:** **- في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب.** **- في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف.**
6	**الانتحال Plagiarism:**

	- في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك
7	**سياسات أخرى Other policies:** - أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات ..... الخ