INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**RENEWABLE ENERGY SOURCES**			
Course Code	**A80324**			
Class	**IV-II**			
Regulation	**R13-JNTUH**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	-	-	4
Course Coordinator	Mrs. T.Vanaja, Assistant Professor, Department of Mechanical Engineering.			
Team of Instructors	Mr. M. Sunil kumar, Assistant Professor, Mrs. T. Vanaja, Assistant Professor.			

I. COURSE OVERVIEW:

Renewable resources include solar energy, wind, falling water, the heat of the earth (geothermal), plant materials (biomass), waves, ocean currents, temperature differences in the oceans and the energy of the tides. Renewable energy technologies produce power, heat or mechanical energy by converting those resources either to electricity or to motive power. The policy maker concerned with development of the national grid system will focus on those resources that have established themselves commercially and are cost effective for on-grid applications. Such commercial technologies include hydroelectric power, solar energy, fuels derived from biomass, wind energy and geothermal energy. Wave, ocean current, ocean thermal and other technologies that are in the research or early commercial stage, as well as non-electric renewable energy technologies, such as solar water heaters and geothermal heat pumps, are also based on renewable resources.

II. PREREQUISITE(S):

Level	Credits	Periods / Week	Prerequisites
UG	4	4	Power Plant Engineering.

III. MARKS DISTRIBUTION:

Sessional Marks (25)	University End Exam Marks	Total Marks
Continuous Assessment Tests (Midterm examinations): There shall be 2 midterm examinations. Each midterm examination consists of one objective paper, one subjective paper and four assignments. The objective paper is for 10 marks and subjective paper is for 10 marks, with duration of 1 hour 20 minutes (20 minutes for objective and 60 minutes for subjective paper). Objective paper is set for 20 bits of – multiple choice questions, fill-in the blanks, 10 marks. Subjective paper contains of 4 full questions (one from each unit) of which, the student has to answer 2 questions, each question carrying 5 marks. First midterm examination shall be conducted for 2.5 units of syllabus and second midterm examination shall be conducted for another 2.5 units. 5 marks are allocated for Assignments. The total marks secured by the student in each midterm examination are evaluated for 25 marks, and the average of the two midterm examinations shall be taken as the final marks secured by each candidate.	75	100

IV. EVALUATION SCHEME:

S. No.	Component	Duration	Marks
1	I Mid Examination	80 Minutes	20
2	I Assignment		5
		TOTAL	**25**
3	II Mid Examination	80 Minutes	20
4	II Assignment		5
		TOTAL	**25**
MID Examination marks to be considered as average of above 2 MID's TOTAL			
5	EXTERNAL Examination	3 hours	75
		GRAND TOTAL	**100**

V. COURSE OBJECTIVES:

After completing this course the student must demonstrate the knowledge and ability to:

I. Explore society's present needs and future energy demands.
II. Understand the need to conserve fossil fuels.
III. Apply different modes of renewable energy sources for optimization of energy production.
IV. Visualize the production of green energy.

VI. COURSE OUTCOMES:

On successful completion of the course, the student will be able to:

1. Visualize various non-conventional sources of energy like wind, biomass and it's applications in remote areas of the country.
2. Describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.
3. Explain the technological basis for harnessing renewable energy sources
4. Recognize the effects that current energy systems based on fossil fuels have over the environment and the society.
5. Describe the main components of different renewable energy systems.
6. Compare different renewable energy technologies and choose the most appropriate based on local conditions
7. Perform simple techno-economical assessments of renewable energy systems.
8. Perform and compare environmental assessments of renewable energy systems and conventional fossil fuel systems.
9. Design renewable/hybrid energy systems that meet specific energy demands are economically feasible and have a minimal impact on the environment.
10. Understand direct energy conversion systems like magento hydrodynamics, thermoelectric and fuels cells.
11. Suggest the best combination of technological solutions to minimize the emission of greenhouse gases and increase the sustainability of the energy system in specific areas/regions.
12. Discuss how to utilize local energy resources (renewable and non-renewable) to achieve the sustainable energy system.
13. Understand and pursue further research work behind the development of non-conventional energy sources as a part of their research work.
14. Evaluate methods for generation of hydrogen power and production of hydrogen.

VII. HOW COURSE OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Capability to apply the knowledge of Mathematics, Science and Engineering in the field of Mechanical Engineering.	H	Assignments, Tutorials
PO2	**Problem analysis**: An ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.	H	Assignments
PO3	**Design/development of solutions**: Competence to design a system, compon ent or process to meet societal needs within realistic constraints.	S	Mini Projects
PO4	**Conduct investigations of complex problems**: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	S	Projects
PO5	**Modern tool usage**: An ability to formulate, solve complex engineering problems using modern engineering and Information Technology tools.	S	Mini Projects
PO6	**The engineer and society**: To utilize the Engineering practices, Techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	H	Assignments
PO7	**Environment and sustainability**: To understand impact of Engineering solutions in the societal context and demonstrate the knowledge for sustainable development.	N	--
PO8	**Ethics**: An understanding and Implementation of professional and Ethical responsibilities.	H	Guest Lecture
PO9	**Individual and teamwork**: To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams.	N	--
PO10	**Communication**: An ability to assimilate, comprehends, communicate, give and receive instructions to present effectively with engineering community and society.	S	Mini Project
PO11	**Project management and finance**: An ability to provide leadership in mana ging complex engineering projects at Multidisciplinary environment and to become a professional engineer.	N	--
PO12	**Life-long learning**: Recognition of the need and an ability to engage in life-long learning to keep abreast with technological changes.	S	Guest Lecture

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** To produce engineering professional capable of synthesi zing and analyzing mechanical systems including allied engineering streams.	H	Lectures, Assignments
PSO2	**Design/Analysis:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	H	Projects
PSO3	**Successful Career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become Technocrat.	S	Guest Lectures

IX. SYLLABUS:

UNIT – I

PRINCIPLES OF SOLAR RADIATION: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT-II

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT-III

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics.

BIO- MASS : Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

UNIT-IV

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy, potential in India.

OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

UNIT-V

DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, and principles of DEC. Thermo-electric generators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions.

TEXT BOOKS:

T1 : Renewable energy resources/ Tiwari and Ghosal/ Narosa.
T2 **:** Non-Conventional Energy Sources /G.D. Rai

REFERENCE BOOKS:

R1 **:** Renewable Energy Sources /Twidell & Weir
R2 : Solar Energy /Sukhame
R3 : Splar Power Engineering / B.S Magal Frank Kreith & J.F Kreith.
R4 : Principles of Solar Energy / Frank Krieth & John F Kreider.
R5 : Non-Conventional Energy / Ashok V Desai /Wiley Eastern.
R6 : Non-Conventional Energy Systems / K Mittal /Wheeler
R7 : Renewable Energy Technologies /Ramesh & Kumar /Narosa

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1	Write the importance of subject	**UNIT-I** Introduction of the subject	T1, 1.1
2	What is the role of RES	**PRINCIPLES OF SOLAR RADIATION** : Role and potential of new and renewable source	T1, 2.3 , T2
3	Describe the solar energy	the solar energy option	T1
4	What are the Environmental impact of solar power	Environmental impact of solar power	T1
5	Describe the physics of sun	Physics of the sun.	T2
6	Define solar constant	The solar constant, extraterrestrial and terrestrial solar radiation	T1, 2.2
7	Analyze the solar radiation on tilted surface	solar radiation on titled surface	T1, 2.8 T2
8	Discuss about the instruments used for measurement of solar radiation and sun shine	instruments for measuring solar radiation and sun shine	T1, 2.5 T2
9	Explain solar radiation data	Solar radiation data	T1, 2.6
10	Describe solar energy collection of flat plate collectors	**UNIT-II** **SOLAR ENERGY COLLECTION** : Flat plate collectors	T1, 3.3
11	Analyze and classify the concentrating collectors	concentrating collectors, classification of concentrating collectors	T1, 3.7, 3.8
12	Describe the orientation of concentrating collectors	orientation of concentrating collectors	T1
13	Evaluate the thermal analysis of collectors	thermal analysis of collectors, advanced collectors.	T1, 3.6, T2
14	Classify the different methods to store solar energy	**SOLAR ENERGY STORAGE AND APPLICATIONS** : Different methods	T1, 4.1
15	Evaluate the Sensible, latent heat and stratified storage of solar energy	Sensible, latent heat and stratified storage of Solar energy	T1
16	Discuss about the solar ponds, Solar Applications- solar heating/cooling technique	solar ponds, Solar Applications- solar heating/cooling technique	T1, 4.3, T2
17	Analyze the solar distillation and drying	Solar distillation and drying	T1, 5.8, T2
18	Evaluate the performance of photovoltaic energy conversion	Photovoltaic energy conversion.	T1, 5.6
19	Classify the sources of wind energy	**UNIT-III** **WIND ENERGY** : Sources and potentials	T1, 6.1
20	Evaluate the performance of horizontal axis wind mills	horizontal axis windmills	T1,6.8.1
21	Evaluate the performance of vertical axis wind mills	vertical axis windmills	T2
22	Interpret the performance characteristics of wind mills	Performance characteristics	T2
23	Analyze the Betz criteria for wind turbine	Betz criteria for wind turbines	T1,T2
24	Solve the problems related to wind energy	Solving the Problems related to the topic	T1
25	Explain the principle of Bioconversion	**BIO-MASS** : Principles of Bio-Conversion,	T1, 7.1

26	What is Anaerobic/aerobic digestion	Anaerobic/aerobic digestion,	T2
27	Classify the types of Bio-gas digesters	Types of Bio-gas digesters, gas yield,	T1,T2
28	Illustrate the combustion characteristics of bio-gas	combustion characteristics of bio-gas,	T2
29	Discuss about the bio-gas utilization for cooking.	bio-gas utilization for cooking,	T1,T2
30	Examine the operation of bio- gas on IC Engine	I.C.Engine operation on bio-gas and economic aspects	T1,T2
31	Identify the importance of Geothermal Energy	**UNIT-IV** **INTRODUCTION TO GEOTHERMAL ENERGY**	T1, 8.1, T2
32	Describe the Resources of Geothermal Energy	Resources of Geothermal Energy	T2
33	Classify the Different Types of wells	Different Types of Wells	T2
34	Analyze the methods of harnessing the energy	Methods of harnessing the energy	T2
35	Explain the geo thermal potential in India.	Geo thermal potential in India.	T1,T2
36	Explain the principles of ocean energy	**OCEAN ENERGY** : OTEC, Principles utilization	T1, 9.1, T2
37	Illustrate the setting of OTEC plants	setting of OTEC plants	T1, 9.2
38	Illustrate thermodynamic cycles	Thermodynamic cycles.	T1,T2
39	What is Tidal and wave energy	Tidal and wave energy: Potential and conversion techniques	T1, 9.3.1
40	Explain about mini hydel power plants	Mini- hydel power plants, and their economics.	T1, 9.5.6
41	Evaluate the performance of thermo electric generators	**UNIT-V** **DIRECT ENERGY CONVERSION** Thermo-electric generators, seeback, peltier and joule Thomson effects,	T1,T2, 12.8
42	Identify the figure of merit materials	Figure of merit, materials, applications	T1,T2, 12.8
43	Explain about MHD generators and its principle	MHD generators and its principle	T1, 12.1
44	What is Dissociation and ionization	Dissociation and ionization, hall effect and magnetic flux	T1, 12.4
45	Describe MHD accelerator, MHD Engine	MHD accelerator, MHD Engine	T1, 12.2
46	What are Power generation systems	Power generation systems, electron gas dynamic conversion	T2, 12.1
47	Explain about the fuel cell and their principles	Economic aspects. Fuel cells, principles	T1, 10.2
48	What are faraday's laws	Faraday's law's, thermodynamic aspects	T1, T2, 10.
49	Discuss about the selection of fuels	Selection of fuels and operating Conditions	T2, 10.22
50	Explain the thermal effects	Thermo-electric generators, seeback, peltier and joule Thomson effects,	T1,T2

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H	H	S	S	S	H					H		H	S	
II	H	H	S										H	S	
III	H	H	S	S				S				S	S	H	
IV	H	H						S				S	H	S	
V	H	H						S					H		S

S =Supportive **H=Highly Related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H	S	S	S	S	H		S		S		S	H	S	
2	S	H	S	S	S	S		H		S		S	S	H	
3	S	S	S	S	S	H		S		S		S	H	S	
4	S	S	S	S	S	S		S		S		S	S	H	
5	H	S											S	H	
6	H			S								S	H	S	
7	S			H									S	H	
8	S	H											H	S	
9			H	H	S							S	S	H	
10	H			S									S	H	S
11	H			S	S								H	S	
12	H		H									S	S	H	S
13	H		S							S		S	S		
14	H		S							S		S	S		

S =Supportive **H=Highly Related**

Prepared by:
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