Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bangalore

	Course Title: **RENEWABLE ENERGY RESOURCES**		
	Scheme (L:T:P) : **4:0:0**	Total Contact Hours: **52**	Course Code: **15ME63C**
	Type of Course: **Lectures, Self Study & Quiz**	Credit **:04**	Core/ Elective: **Elective**
CEE:25 Marks			SEE:100 Marks

Prerequisites: Knowledge of Applied science, Thermal engineering

Course Objectives:

The energy has become an important and one of the basic infrastructures for the economic development of the country. it is imperative for the sustained growth of the economy. This course envisages the new and renewable source of energy, available in nature and to expose the students on sources of energy crisis and the alternates available, also stress up on the application of non-conventional energy technologies.

Course Outcomes:

On successful completion of the course, the students will be able to attain CO:

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Understand the need of energy conversion and the various methods of energy storage	**R/U/A**	2	**08**
CO2	Explain the field applications of solar energy	**R/U/A**	2,6	**12**
CO3	Identify Winds energy as alternate form of energy and to know how it can be tapped	**R/U/A**	2,6	**11**
CO4	Explain bio gas generation and its impact on environment	**R/U/A**	2,6	**06**
CO5	Understand the Geothermal &Tidal energy, its mechanism of production and its applications	**R/U/A**	2,6	**07**
CO6	Illustrate the concepts of Direct Energy Conversion systems & their applications.	**R/U/A**	2,6	**08**
		Total sessions		**52**

Legend: R: Remember U: Understand A: Application

COURSE-PO ATTAINMENT MATRIX

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
RENEWABLE ENERGY RESOURCES	0	3	0	0	0	2	0	0	0	0

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed

COURSE CONTENT AND BLUE PRINT OF MARKS FOR SEE

Unit No	Unit Name	Hour	Questions to be set for SEE/Marks			Marks weightage	weightage (%)
			R	U	A		
1	ENERGY CONSERVATION& STORAGE	08	5	10	10	25	17.24
2	SOLAR ENERGY	10	5	15	10	30	20.68
3	WIND ENERGY	08	5	5	10	20	13.80
4	BIO MASS ENERGY	08	5	5	10	20	13.80
5	GEO THERMAL & TIDAL ENERGY	10	5	15	10	30	20.68
6	DIRECT ENERGY CONVERSION SYSTEMS	08	5	5	10	20	13.80
	Total	52	30	55	60	145	100

Legend: R; Remember, U: Understand A: Application

UNIT I: ENERGY CONSERVATION & STORAGE 08 Hrs

Energy- Energy Sources & their Availability - Importance of Renewable Energy Resources - Principles of energy conservation- Energy storage- Necessity of energy storage-Energy storage methods- Mechanical Energy storage -Pumped storage-Compressed air storage-Electrical Storage -Lead Acid Battery -Chemical Storage -Energy storage via hydrogen - Electromagnetic energy storage.

UNIT II: SOLAR ENERGY 10 HRS

Solar energy - Introduction-Solar constant- Solar Radiation at the Earth's surface-measurements of solar radiation-pyronometer- pyrheliometer- sunshine recorder –Solar collectors-Classification-liquid flat plate collector-construction-effect of various parameter on its performance-Concentrating collector-Focusing and non-focusing type-Applications of

Solar Energy - solar water heater- Solar Cooker-Box type- Solar dryer-solar greenhouse—Summer and winter greenhouse-solar electric power generation-Solar photovoltaic.

UNIT III: WIND ENERGY 08 HRS

Introduction- Basic Principles of Wind energy conversion-The nature of wind- The power in the wind (No derivations)- Forces on the Blades (No derivations)-Site Selection considerations-Basic components of a wind energy conversion system (WECS)-Advantages & Limitations of WECS-Wind turbines (Wind mill)-Horizontal Axis wind mill-Vertical Axis wind mill-performance of wind mills-Environmental aspects

UNIT IV: BIOMASS ENERGY 08 Hrs

Introduction- Biomass conversion techniques-Biogas Generation-Factors affecting biogas Generation-Types of biogas plants- Advantages and disadvantages of biogas plants-urban waste to energy conversion-MSW incineration plant.

UNIT V: GEO THERMAL & TIDAL ENERGY. 10 HRS

Geothermal Sources-Hydro thermal Sources- a. Vapor dominated systems b. Liquid dominated systems -Prime movers for geothermal energy conversion-Tidal Energy-Basic Principles of Tidal Power-Components of Tidal Power Plants- Schematic Layout of Tidal Power house-Advantages & Limitations of Tidal power.

UNITVI: DIRECT ENERGY CONVERSION SYSTEM 08 Hrs

Thermo - Electric power- Basic Principles-Thermo electric power generator-Thermionic Generation –Introduction-Thermionic emission & work function-Basic Thermionic generator-Chemical Energy Sources-Introduction-Fuel cells – Principles of operation, classification & Types-Applications of fuel cells.

TEXT BOOKS

Sl.No.	Title of Books	Author	Publication
1.	Non-Conventional energy sources.	G.D.Rai	Khanna Publishers
2.	Non-Conventional energy sources-2 E	B.H.Khan	Tata McGraw Hill
3.	Renewable Energy Sources & Emerging Technologies.	D P Kothari, K C Singal&RakeshRanjan	Prentice Hall India
4	Solar energy.	H.P.Garg	McGraw Hill-Education
5.	Energy opportunities and social responsibility.	Satyesh C. Chakraborty	Jaico publications

LIST OF SOFTWARES/ LEARNING WEBSITES:

i. http://nptel.ac.in/courses/112105051/
ii. https://www.youtube.com/watch?v=Ota2_LUuar0
iii. https://www.youtube.com/watch?v=Ota2_LUuar0
iv. https://www.youtube.com/watch?v=3dJAtHaSQ98
v. https://www.youtube.com/watch?v=xokHLFE96h8
vi. http://www.tatapower.com/businesses/renewable-energy.aspx
vii. http://www.cleanlineenergy.com/technology/wind-and-solar
viii. https://www.youtube.com/watch?v=kbuLfXgw4Gs
ix. https://www.youtube.com/watch?v=r9q80sSHxKM
x. https://www.youtube.com/watch?v=GZKKWz_tX1c
xi. download other power plant related videos from youtube.com for study purpose.

SPECIAL INSTRUCTIONAL STRATEGIES

UNIT NO	UNIT NAME	STARATEGIES
1	**Energy conservation& storage**	lectures and Power point presentations/ Video/ Video movies
2	**Solar energy**	Lectures/Presentations, Showing charts, Video movies, Industrial visits to solar Installation units
3	**Wind energy**	Lectures/Presentations, Showing charts, Video movies, Industrial visits to wind mills
4	**Bio mass energy**	Lectures/Presentations, Showing chart, Industrial visits to nearby Bio mass plant
5	**Geo thermal & tidal energy**	Lectures/Presentations, Showing chart,
6	**Direct energy conversion systems**	Lectures/Presentations, Showing chart, Expose to real life industries situation, industrial visits

SUGGESTED LIST OF STUDENT ACTIVITYS

Note: the following activities or similar activities for assessing CIE (IA) for 5 marks (Any one)

- Each student should do any one of the following type activity or similar activity related to the course and before take up, get it approved from concerned Teacher and HOD.
- Each student should conduct different activity and no repeating should occur

1	Prepare a of monthly energy consumption of your institute and find the ways how it can be conserved
2	Conduct an energy audit of your institute; suggest the ways how the conventional energy resources utilization can be minimized. Suggest the areas ,where the non-conventional energy may be used
3	Identify the solar intensity and wind speed in your institute locality and calculate the intensity of Solar/Wind Power can be generated.
4	Visit to web site of ministry of renewable energy ,Government of India: http://mnre.gov.in/ make a Study on 'Developmental Impact and Sustainable Governance aspects of Renewable Energy Projects'
5	Visit solar power plant /wind power plant available in your locality/ nearer to your institute and understand different elements, working, and note the power generation by these plants

Course Assessment and Evaluation Scheme:

	What		To whom	When/Where (Frequency in the course)	Max Marks	Evidence collected	Course outcomes
Direct Assessment	CIE	IA	Students	Three IA tests(Average of three tests will be computed)	20	Blue books	1,2,3,4,5,6
				Student activities	05	Activity sheets	1,2,3,4,5,6
	SEE	End Exam		End of the course	100	Answer scripts at BTE	1,2,3,4,5,6
Indirect Assessment	Student Feedback on course		Students	Middle of the course		Feedback forms	1,2,3 Delivery of course
	End of Course Survey			End of the course		Questionnaires	1,2,3,4,5,6 Effectiveness of Delivery of instructions & Assessment Methods

CIE- Continuous Internal Evaluation SEE- Semester End Examination

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Note to IA verifier*: *The following documents to be verified by CIE verifier at the end of semester

1. Blue books (20 marks)
2. Student suggested activities report for 5 marks and should be assessed on RUBRICS
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods.

- **MODEL OF RUBRICS /CRITERIA FOR ASSESSING STUDENT ACTIVITY**

RUBRICS MODEL

RUBRICS FOR ACTIVITY(5 Marks)						
Dimension	**Unsatisfactory**	**Developing**	**Satisfactory**	**Good**	**Exemplary**	**Student Score**
	1	**2**	**3**	**4**	**5**	
Collection of data	Does not collect any information relating to the topic	Collects very limited information; some relate to the topic	Collect much information; but very limited relate to the topic	Collects some basic information; most refer to the topic	Collects a great deal of information; all refer to the topic	Ex: 4
Fulfill team's roles & duties	Does not perform any duties assigned to the team role	Performs very little duties but unreliable.	Performs very little duties	Performs nearly all duties	Performs all duties of assigned team roles	5
Shares work equally	Always relies on others to do the work	Rarely does the assigned work; often needs reminding	Usually does the assigned work; rarely needs reminding	Normally does the assigned work	Always does the assigned work without having to be reminded.	3
Listen to other Team mates	Is always talking; never allows anyone else to speak	Usually does most of the talking; rarely allows others to speak	Talks good; but never show interest in listening others	Listens, but sometimes talk too much	Listens and speaks a fair amount	2
Average / Total marks=(4+5+3+2)/4=14/4=3.5=4						

Note: This is only an example. Appropriate rubrics/criteria may be devised by the concerned faculty (Course Coordinator) for assessing the given activity.

MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th weak of sem 10-11 Am	VI SEM	**RENEWABLE ENERGY RESOURCES**	20
	Year: 2016-17	Course code:15ME63C	

Name of Course coordinator : Units:1,2 Co: 1,2

Note: Answer all questions

Question no	Question	MARKS	CL	CO	PO
1	List out the primary and secondary energy sources OR What are the categories of energy storage system.	5	R	1	2,6
2	Explain lead acid battery, with a neat sketch	5	U	1	2,6
3	Define solar collectors and list the types of collectors	5	R	2	2,6
4	1. Identify the sources of commercial energy. OR 1. Analyse, the sun tracking helps in energy collection by a flat plate solar collector.	5	A	1,2	2,6

MODEL QUESTION PAPER

VI- Semester Diploma Examination

Course Title: **RENEWABLE ENERGY RESOURCES**

Time: **3 Hours**] [Max Marks**: 100**

Note: Answer any **SIX from Part A** and any **SEVEN from Part B**

PART-A 6x5=30 marks

1. What is the necessity of energy conservation and list its various aspects.
2. List the advantages and disadvantages of wind turbines
3. Identify the applications and advantages of flat plate collector.
4. List the usable forms of biomass, their composition and fuel properties
5. Explain the five categories geothermal sources
6. List the advantages and disadvantages of fuel cells
7. Explain solar greenhouse
8. Explain hydro thermal sources
9. Explain briefly about bio diesel plants

PART-B 7x10=70 marks

1. Explain the various aspects of energy conservation.
2. Explain about the solar collectors and its types
3. Explain the forces acting on wind blades.
4. Explain with a neat sketch fixed dome digester
5. Compare the relative performances of a floating drum and fixed dome type biogas plants.
6. Explain with a neat sketch basic thermo ionic generator.
7. Select the considerations for site to install tidal energy .
8. Illustrate the seeded inert gas system with a neat sketch.
9. Making use of a sketch explain the single basic arrangement of tidal power generation.
10. Explain with a neat sketch seeded inert gas system.

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MODEL QUESTION BANK

Diploma in Mechanical Engineering
IV Semester
Course title: MECHANICS OF MACHINES

CO1: understand the need of energy conversion and the various methods of energy storage

REMEMBERING

1. Define primary and secondary energy sources.
2. Define Renewable and non renewable energy sources.
3. List out primary and secondary energy sources.
4. List the various Renewable and non renewable energy sources.
5. List the advantages and limitations of conventional energy sources.
6. List the advantages and limitations of non conventional energy sources.
7. List the categories of energy storage system.

UNDERSTANDING

1. Explain conventional energy sources.
2. Explain the concept of renewable energy
3. Explain the primary and secondary sources and their availability.
4. Explain the importance of renewable energy sources compared to Non renewable energy sources.
5. Explain the necessity of energy conservation and its various aspects.
6. Explain various principles of energy conservation.
7. Explain energy storage concepts and list the devices available.
8. Explain the necessity of energy storage system
9. Explain pumped hydro-electric energy storage system with a schematic diagram.
10. Explain compressed air storage system with a schematic diagram.
11. Explain lead acid battery, with a neat sketch.
12. Explain chemical energy storage via hydrogen.

APPLICATION

2. Develop the per-capita energy consumption related with standard of living.
3. Identify the sources of commercial energy.
4. Identify the necessity of energy conservation and Explain its various aspects

CO2 : Explain the field applications of solar energy

REMEMBERING

1. Define solar constant.
2. Define beam, diffused and global radiation
3. Define solar irradiance, solar constant, extra terrestrial and terrestrial radiations

4. Define solar collectors and list the types of collectors.
5. List the applications of flat plate collector.
6. Label the different parts of a parabolic collector with a neat sketch.
7. List the advantages and disadvantages of concentrating collector over flat plate collector.
8. List the advantages and disadvantages of flat plate collector

UNDERSTANDING

1. Explain solar energy engineering.
2. Explain the amount of solar energy available at the earth's surface with suitable equation.
3. Infer the average amount of solar energy available at the day time.
4. Explain about solar radiation measurements.
5. Explain beam radiation, diffused radiation and global radiation.
6. Summarise the reasons for variation in solar radiation reaching the earth than received at outside of the atmosphere
7. Explain pyrheliometer and pyronometer.
8. Explain in brief about sunshine recorder.
9. Explain the construction and principle of operation of a sunshine recorder.
10. Explain basic features required in an ideal pyronometer.
11. Explain with a neat sketch typical flat plate liquid collector.
12. Explain with a neat sketch solar air heater and air collector.
13. Explain parabolic focussing collector.
14. Explain non focussing collector (Flat plate collector augmented with mirrors).
15. Explain the effect of various parameters on the performance of flat plate collector.
16. Explain the effect of various parameters on the performance of concentrating collector.
17. Explain with a neat sketch solar water heater.
18. Explain with a neat sketch box type solar cooker.
19. Explain with a neat sketch working of solar dryer.
20. Explain solar greenhouse.
21. Explain briefly about the supply of adequate amount of CO_2 maintained in greenhouse.
22. Explain with a neat sketch winter green house.
23. Explain with a neat sketch summer green house.
24. Explain the principle of solar electric power generation (solar photovoltaic).
25. Explain selective coatings used in solar collectors.

APPLICATION

2. Identify the reasons for solar energy collection getting affected by tilting a flat plate collector with respect to the ground.
3. Analyse, the sun tracking helps in energy collection by a flat plate solar collector.
4. Choose the best coatings used in solar collectors for higher efficiency.
5. Select the best two applications of solar energy and explain in brief.

CO3: Identify wind energy as alternate form of energy and to know how it can be tapped

REMEMBERING

1. List the forces responsible for determining the speed and direction of global winds.
2. List the factors led to accelerated development of wind power?
3. List the factors affecting the distribution of wind energy system on the surface of the earth.

4. List the advantages and disadvantages of wind turbines.
5. List the advantages and limitations of horizontal wind turbine.
6. List the advantages and limitations of vertical wind turbine.
7. How wind energy impacts on Environment.

UNDERSTANDING

1. Outline the circulation of global winds with a help of schematic diagram.
2. Explain the mechanism for production of local winds.
3. Infer the range of wind speed is considered favourable for wind power generation.
4. Explain the basic principle of wind energy conversion.
5. Explain the forces acting on wind blades.
6. Explain the concept of lift and drag.
7. Explain the relative features of lift and drag type machines.
8. Summarise the main considerations in selecting a site for wind generators.
9. Explain with a neat sketch working of a wind energy conversion system(WECS) with main components.
10. Explain the components of wind energy conversion systems.
11. Explain with neat sketch horizontal and vertical axis wind system.
12. Explain the present prospectus of wind energy in India.

APPLICATION

1. Choose the favourable factors required in site for installing the wind turbines.
2. Choose the favourable factors for selecting a site for installing wind generators.

CO4: Explain bio gas generation and its impact on environment

REMEMBERING

1. List the usable forms of biomass, their compositions.
2. List the fuel properties.
3. List the advantages and disadvantages of biomass energy
4. List the main advantages of anaerobic digestion of biomass
5. List the factors affecting biogas generation.
6. What are the advantages and disadvantages of biogas plants.
7. List the main plants proposed for energy plantation.

UNDERSTANDING

1. Summarise in brief about the introduction of bio energy engineering.
2. Explain the process of formation of bio-mass energy.
3. Explain clearly the term biomass and biogas.
4. Explain different types of bio fuels.
5. Explain thermo chemical conversions, fermentation and anaerobic digestion.
6. Explain the composition of biogas.
7. Illustrate the various biomass conversion processes.
8. Illustrate biogas processes such digestion.
9. Explain the types of biogas plant.
10. Explain with a neat sketch floating drum type biogas plant.
11. Explain with a neat sketch fixed dome digester.
12. Compare the relative performances of a floating drum and fixed dome type biogas plants.
13. Explain with the help of block diagram ,the working of MSW incineration plant.

14. Illustrate about urban waste to energy conversion via MSW incineration method
15. Explain energy plantation, list the advantages and disadvantages
16. Explain briefly about bio diesel plants

APPLICATION

1. Identify the various biomass conversion processes.
2. Making use of a sketch explain the types of biogas plants
3. Develop the general approximate composition of MSW, discuss its heating value and discuss the problems in its development
4. Making use of MSW incineration method, how to convert urban waste in to energy.

CO5: Understand the geothermal &tidal energy, its mechanism of production & its applications

REMEMBERING

1. Define geothermal sources.
2. What is geothermal energy.
3. List the advantages and disadvantages of geothermal energy forms.
4. List the main applications of geothermal energy.
5. Choose the places of geothermal occurrence in India.
6. List the advantages and disadvantages of tidal power.
7. List the main hurdles in development of tidal energy.
8. Choose the potential sites for tidal energy in India .

UNDERSTANDING

1. Infer the origin and distribution of geothermal energy
2. Infer the nature of geothermal fields.
3. Explain the five categories geothermal sources.
4. Explain hydro thermal sources.
5. Explain with a neat sketch vapour dominated systems.
6. Explain with a neat sketch liquid dominated systems.
7. List the various applications of direct heating and Electric generation .
8. Illustrate the environmental impacts of geothermal energy .
9. Infer the present prospectus of geothermal energy in context to India.
10. Explain the sources of tidal energy, Discuss the minimum tidal range required for practical tidal plant.
11. Explain the basic principles of tidal power.
12. List the components of tidal power plants.
13. Explain with a neat sketch tidal power plant
14. Explain with a neat sketch the single basic principle of tidal power generation.
15. Explain the considerations for site selection of tidal energy.
16. Infer the prospectus of tidal power in India.

APPLICATION

1. Identify various the categories of geo-thermal fields.
2. Making use of diagram explain the Vapour dominated and Liquid dominated systems..

3. Identify the various applications of direct heating and Electric generation .
4. Identify the environmental impacts of geothermal energy.
5. Select the considerations for site to install tidal energy.

CO6: Illustrate the concepts of direct energy conversion systems & their applications.

REMEMBERING

1. List the MHD systems and classifications of MHD systems.
2. List the advantages of MHD systems.
3. What are the sources of chemical energy.
4. List the advantages and disadvantages of fuel cells.
5. What are the applications of fuel cells.

UNDERSTANDING

1. Explain the meaning of direct energy conversion systems.
2. Illustrate the principle of MHD generation.
3. Compare Open and closed cycle MHD system.
4. Explain with a neat sketch seeded inert gas system.
5. Explain the see beck effect and principle of thermo couple.
6. Explain joule effect, peltier effect and Thomson effect.
7. Explain thermo electric power generators.
8. Explain thermionic emission and work function.
9. Explain with a neat sketch basic thermo ionic generator
10. Illustrate the principle of operation of fuel cell.
11. Explain the types of fuel cell
12. Classify the fuel cells

APPLICATION

1. Identify the sources of chemical energy .
2. Making use of a Sketch, explain the seeded inert gas system