SARVAJANIK UNIVERSITY

Sarvajanik College of Engineering and Technology

Bachelor of Technology

Mechanical Engineering Department

B. Tech. Semester VI

Course Name: **Energy Conservation and Management** **Course Code: BTME19523**

Type of course: **Honors - Energy Systems**

Prerequisite: Basics of Environment Studies, Basics of Mechanical Engineering, Thermodynamics

Rationale of course: This course is prepared to provide detailed understanding of 3Es (Energy, Economics and Environment) and their interaction. Students will learn and understand energy conservation, energy management, energy audit, financial management and to enhance efficiency in different thermal utilities and systems.

Teaching and Examination Scheme:

Teaching scheme				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
4	0	2	5	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Energy Scenario:** Classification of Energy, Indian energy scenario, sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future, Energy Conservation Act 2001 and its features, schemes of Bureau of Energy Efficiency (BEE)	7	12 %

Sr. No.	Topics	Teaching Hrs.	Module Weightage
2	**Energy Management & Audit:** General principles of energy management and energy management planning, definition, energy audit, need, types of energy audit. conducting energy audit (pre-audit, audit and post-audit), energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies(Energy efficiency analysis), optimizing the input energy requirements, fuel and energy substitution, energy audit instruments metering, monitoring, evaluating and following up energy saving measures/ projects, case study.	**8**	**13 %**
3	**Financial Management :** Investment-need, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs)	**7**	**12 %**
4	**Energy conservation:** Energy conservation in pumps, fans (flow control), compressed air systems, refrigeration & air conditioning systems.	**6**	**10 %**
5	**Energy Efficiency in Thermal Utilities and systems:** **Boilers:** Types, combustion in boilers, performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. Boiler efficiency calculation, evaporation ratio and efficiency for coal, oil and gas. Soot blowing and soot deposit reduction, reasons for boiler tube failures, start up, shut down and preservation.	**16**	**26%**

Sr. No.	Topics	Teaching Hrs.	Module Weightage
	Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings. Steam utilization, performance assessment of steam system, thermo- compressor, steam pipe insulation, condensate pumping and steam dryers.		
6	**Insulation and Refractories:** Insulation-types and application, economic thickness of insulation, heat savings and application criteria, refractory-types, selection and application of refractories, heat loss. cold insulation. **Heat Exchangers:** Types, networking, multiple effect evaporators, condensers, distillation column, etc., energy saving in heat exchanger. **Waste Heat Recovery:** Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential. **Cogeneration:** Definition, need, application, advantages, classification, saving potentials. Heat balance, steam turbine efficiency, tri-generation, micro turbine.	**16**	**27%**

Percentage Distribution of Marks as per Bloom's Taxonomy (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**30**	**25**	**15**	**10**	**5**

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels **(Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

Sr. No.	Title of book /article	Author(s)	Publisher	Publication Year	Publication Edition
1	Energy Conservation Guidebook	Dale R Patrick, Stephen W Fardo,	Rivers publishers	2020	3rd
2	Handbook of Energy Audits,	Albert Thumann,Terry Niehus,William J.Younger	River Publishers	2012	9th
3	Bureau of Energy Efficiency	BEE	BEE	-	-
4	Energy Management Handbook	W.C. Turner, John Wiley and Sons,	River publication	2020	9th
5	Energy management and conservation	K.V.Sharma & P Venkataseshaiah	Dream tech Press	2020	-

Course Outcomes (COs):

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Summarize the energy conservation scenario, energy and environment, air pollution, climate change, and various acts and policy for the energy conservation	12
CO-2	Apply the knowledge of energy audit for the energy management and operation of energy audit instruments	13
CO-3	Infer the concept of financial management and their terminology.	12
CO-4	Interpret energy conservation in different devices like pumps, fans and refrigeration & air conditioning systems.	10
CO-5	Identify the energy saving area and improvement in efficiency of various thermal systems	26
CO-6	Analyse the waste heat recovery systems and implementation of insulation, refractories and cogeneration with the systems.	27

Mapping of COs with Program Outcomes (POs & PSOs)

	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO-1	3	0	0	0	0	3	2	1	1	1	1	2	3	1	3
CO-2	3	2	0	0	0	1	1	2	1	1	2	2	1	1	2
CO-3	0	1	0	0	0	1	1	1	1	2	2	2	1	1	2
CO-4	3	1	1	1	0	1	1	1	1	1	3	3	1	1	3
CO-5	3	2	1	0	0	1	1	1	2	1	3	2	1	1	3
CO-6	3	2	0	0	0	1	2	1	1	1	3	2	1	1	3
Rationale*	**15**	**8**	**2**	**1**	**0**	**8**	**8**	**7**	**7**	**7**	**14**	**13**	**8**	**6**	**16**

***Rationale - Mapping of COs with POs and COs with PSOs:**

It will help to develop engineering knowledge of energy conservation, energy management, energy audit and financial management. It also enhance the project management and finance skills and apply the life-long knowledge for technological change.

This course highly maps with Program outcomes 1, 2,6,7,11,12 and Program Specific Outcomes 3.It states that the course will develop Engineering knowledge, Problem analysis, The engineer and society, Environment and sustainability, Project management and finance, Life-long learning and Finally it will lead to, Apply their technical, managerial and other soft skills in their professional life.

List of Practical:

1) Study of Energy Conservation Act 2001, its features and schemes of Bureau of Energy Efficiency (BEE).
2) Study of electricity bill understanding and calculation.
3) Case study on energy management.
4) Study of energy conservation in different systems.
5) Case study on boiler performance.
6) Study of waste heat recovery system used for energy conservation.
7) Case study on insulation and refractories used in different thermal systems.

List of Open learning website:

1. https://nptel.ac.in/courses/112105221
2. https://nptel.ac.in/courses/108106022
3. https://onlinecourses.nptel.ac.in/noc20_mm20/preview
4. www.beeindia.gov.in

Mechanical Engineering Department
B. Tech. Semester V

Course Name:	**Renewable Energy Engineering**	**Course Code: BTME19523**
Type of course:	**Honors - Energy Systems**	
Prerequisite:	Fundamental knowledge of fluid mechanics and heat transfer.	
Rationale of Course:	The students will able to understand basic concepts of new evolving renewable energies such as solar energy, bio energy, wind energy, etc. They will be able to think a new solutions which provide alternates for conventional fuel consumption.	

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
4	0	2	5	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Contents:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**Current Energy Scenarios:** Present energy scenario of conventional and renewable sources, requirement of alternate energy sources, need of renewable energy sources, limitations of renewable energy.	2	4%
2.	**Basics of Solar Energy:** Solar radiation outside the earth's atmosphere and at the earth's surface, Instruments for measuring solar radiation and sunshine, energy available from the sun, spectral distribution, solar radiation geometry, empirical equations for prediction of availability of solar radiation on horizontal and tilted surface.	14	24%

Sr. No.	Topics	Teaching Hrs.	Module Weightage
3.	**Solar Liquid Flat Plate Collector:** Introduction, types and working of solar concentrating collectors, performance analysis of solar liquid flat plate collector, transmissivity of the cover, transmissivity-absorptivity product, losses in liquid flat plate collector, collector efficiency factor, collector heat removal factor.	**14**	**24%**
4.	**Solar Energy Applications:** Construction and working of solar air heater, cylindrical parabolic collector, compound parabolic collector, paraboloid dish collector, central receiver collector, solar energy thermal storage, solar pond, solar cooker, solar still, solar drier, heliostat, solar furnace, photovoltaic system for power generation, solar cell modules and arrays.	**8**	**12%**
5.	**Wind Energy:** Energy available from wind, basics of lift and drag, basics of wind energy conversion system, Betz limit theory, effect of density, angle of attack and wind speed, wind mill rotors, horizontal and vertical axes rotors, drag, lift, torque and power coefficients, tip speed ratio, solidity of turbine, wind turbine performance curves, wind energy potential and site selection, basics of wind farm, Safety and environmental aspects, wind energy potential and installation in India.	**10**	**16%**
6.	**Bio Energy**: Biomass energy – modern energy carrier, energy plantation, gasification, types and applications of gasifiers, types of biogas plants, design of biogas plant, factors affecting biogas generation, advantages and disadvantages.	**6**	**10%**

Sr. No.	Topics	Teaching Hrs.	Module Weightage
7.	**Other Energy Sources**: Ocean and wave thermal energy conversion principle, open, closed and hybrid cycle OTEC system, energy from tides, estimation of tidal power, tidal power plants, single and double basin plants, site requirements, advantages and limitations Geothermal energy introduction, vapor and liquid dominated systems, binary cycle, hot dry rock resources, magma resources, advantages and disadvantages, applications.	6	10%

Percentage Distribution of Marks as per Bloom's Taxonomy (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**15**	**25**	**25**	**15**	**10**

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

Reference Books:

Sr. No.	Title of book /article	Author(s)	Publisher	Publication year	Publication edition
1.	Solar Energy: Principles of Thermal Collection and Storage	S. P. Sukhatme and J. K. Nayak	McGraw Hill Publishing Company Ltd.	2008	3rd
2.	Solar Engineering of Thermal Processes, Photovoltaics and Wind	John A. Duffie, William A. Beckman	John Wiley, New York	2020	5th
3.	Principles of Solar Engineering	D. Y. Goswami, F. Kreith and J. F. Kreider	CRC Press, Taylor and Francis.	2014	3rd
4.	Solar Energy: Fundamentals and Applications	H. P. Garg and Jai Prakash	McGraw Hill Publishing Company Ltd.	2017	2nd
5.	Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization	R. Petela	McGraw Hill Publishing Company Ltd.	2010	1st

Course Outcomes (CO's):

CO. No.	CO Statements After learning this subject, students will be able to	Marks % weightage
CO-1	Identify and recognize the various renewable energy specifically solar energy	20
CO-2	Analyze and design the performance of various solar applications.	40
CO-3	Determine the potential of wind energy conversion systems.	20
CO-4	Illustrate Bio energy, Wave energy, Ocean energy and Geothermal Energy.	20

Mapping of (CO's) with Program Outcomes (PO's) and Program Specific Outcomes (PSO's):

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO-1	3	3	1	0	1	3	2	0	1	0	2	1	2	1	1
CO-2	3	2	3	2	2	2	1	0	1	0	2	1	3	2	2
CO-3	1	1	1	0	0	1	2	0	0	0	0	2	1	1	1
CO-4	1	1	1	0	1	2	1	0	0	0	0	2	1	0	0
Rationale*	**8**	**7**	**6**	**2**	**4**	**8**	**6**	**0**	**2**	**0**	**4**	**6**	**7**	**4**	**4**

Rationale - Mapping of CO's with PO's and CO's with PSO's:

It states that the course will develop engineering knowledge, addresses societal, health and environmental issue with the aid of knowledge of renewable energy.

This course highly maps with Program outcomes 1,2,3,6,7,12 and Program Specific Outcomes 1. It states that the course will develop engineering knowledge, problem analysis, design / development of solutions, the engineer and society, environment and sustainability, life-long learning and finally it will lead to convert conceptual knowledge of mechanical engineering to real life application.

List of Practical:

1. To study and measure the solar radiation on horizontal and tilted surface using solar radiation measuring instruments.
2. To evaluate the performance of solar liquid flat plate collector.
3. To study the performance of solar air heater.
4. To study the performance of concentrating collectors.
5. To evaluate the performance of solar still.
6. To evaluate the performance of box type solar cooker.
7. To study the various types of wind mill and evaluate the performance parameter of wind mill.
8. To study the various types of gasifier and biogas plant.
9. To study the ocean energy, wave energy, geothermal energy conversion systems.

Major Equipment:

1. Solar power meter
2. Solar liquid flat plate collector
3. Box type solar cooker
4. Solar still

List of open learning website:

1. https://nptel.ac.in/courses/115103123