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ALTERNATIVE ENERGY SOURCES AND ENERGY MANAGEMENT **Course Code : 316364**

Programme Name/s : **Mechanical Engineering**
Programme Code : **ME**
Semester : **Sixth**
Course Title : **ALTERNATIVE ENERGY SOURCES AND ENERGY MANAGEMENT**
Course Code : **316364**

I. RATIONALE

The conventional energy resource is limited in nature and will be exhausted in future. With increasing environmental concerns and depleting fossil fuels, its necessary to understand and work with renewable energy sources like solar, wind, and biomass. Recently significant advances are made in utilization of solar energy in heating and electrical energy conversion applications. Biomass and bio fuels are also getting importance. This course is designed for diploma students to acquire skills in operating and maintaining the renewable energy technologies for its proper utilization through energy management practices.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experience: Maintain various types of renewable energy systems efficiently and economically following standard procedures.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select proper instruments for performing energy audit.
- CO2 - Identify energy conservation opportunities in mechanical and electrical systems.
- CO3 - Design cost effective solar thermal and photovoltaic system as per requirement.
- CO4 - Utilize wind and biomass as a renewable energy technology for energy generation.
- CO5 - Select suitable source(s) of energy generation using principles of renewable energy.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316364	ALTERNATIVE ENERGY SOURCES AND ENERGY MANAGEMENT	AEM	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

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Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Classify renewable and non-renewable energy sources TLO 1.2 Explain the role of energy sources in a growing economy. TLO 1.3 Select relevant instruments to perform energy audit TLO 1.4 Describe energy audit and its importance in the context of energy management. TLO 1.5 Differentiate between a preliminary energy audit and a detailed energy audit. TLO 1.6 State the requirements and scope of ISO 50001 and ISO 50002.	**Unit - I Energy Scenario and Audit** 1.1 Types of energy sources- Commercial energy and noncommercial energy, renewable and non-renewable energy. 1.2 Sector wise renewable energy consumption in India, energy needs of growing economy, energy pricing, energy security, National Action Plan on Climate Change (NAPCC), integrated energy policy and its need. 1.3 Definition, Energy audit- need, types of energy audit and methodology – preliminary energy audit and detailed energy audit, energy units and conversion. 1.4 Electrical Energy, electrical load management and maximum demand control, power factor improvements, energy efficient equipment’s and appliances, star rating 1.5 Instruments and metering for Energy audit – Auto digital clamp meter, lux meters, pyranometer, sunshine recorder, pyrheliometer, combustion gas analyzer, psychrometer, fyrite. Selection of above instruments. 1.6 Introduction to ISO 50001: Energy management and energy savings, ISO 50002: Energy audit requirement.	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the need and importance of the energy conservation act-2001. TLO 2.2 Prepare energy flow within a system using sankey diagram. TLO 2.3 Develop an energy monitoring and targeting plan TLO 2.4 Recommend energy conservation opportunities in mechanical and electrical systems.	**Unit - II Energy Management and Conservation** 2.1 Definition and objectives of energy management, energy conservation act-2001 and its features, need for energy management program, need and importance of energy conservation and management, sankey diagram, specific energy consumption. 2.2 Energy Monitoring and Targeting - Definition, elements of monitoring and targeting, benefits of monitoring and targeting. 2.3 Energy conservation opportunities in mechanical systems – Water Pumps, steam distribution system and its losses, steam leakage, air leakage, fans and blowers, cooling towers, Heating Ventilation & Air Conditioning (HVAC) systems. 2.4 Energy conservation opportunities in electrical systems – Lightning system, diesel gas energy power generation system, electrical motors, industrial drive, variable speed drive.	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study
3	TLO 3.1 Classify solar thermal system on the basis of given parameters. TLO 3.2 Select concentrated solar collector for given application with justification. TLO 3.3 Design a stand-alone solar photovoltaic system and pumping system for residential application. TLO 3.4 Select a suitable solar dryer for drying of food products on large scale with suitable justification.	**Unit - III Direct use of Solar Energy** 3.1 Solar Thermal Systems – Classification of solar thermal system ,Types of solar collectors- Flat Plate Collectors (FPC), Evacuated Tube Collector (ETC), natural and forced circulation water heating system , design and costing of solar water heating system (Simple numerical) 3.2 Solar concentrating collectors – Parabolic collectors, parabolic dish collector and solar tower. Solar dryers - Classification, construction, working and applications in commercial, agricultural, domestic sector. Applications of solar energy. 3.3 Solar Photovoltaic (PV) Systems - Solar photovoltaic technologies - advantages and limitations. Solar PV system - types and their Components - Solar Cell modules , panels and array. Solar cell connecting arrangements, solar PV module ratings and cost, battery ratings and cost, inverter ratings and cost, Maximum Power Point Tracking (MPPT). 3.4 Stand-alone photovoltaic System: Home lighting and other usage - Solar PV system designing, cost estimation of a PV System, solar PV water pumping system, design of solar PV pumping System (Simple numerical), Net Metering, Open Access and Power Purchase Agreements (PPA)	Lecture Using Chalk-Board Presentations Model Demonstration Site/Industry Visit Case Study

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 State the criteria for site selection of wind energy conversion system. TLO 4.2 Describe wind energy conversion system using block diagram. TLO 4.3 Identify the types and components of wind energy conversion systems. TLO 4.4 State the reasons to consider compressed bio gas as biofuel. TLO 4.5 Explain the role of India's national policy on biofuels in promoting sustainable energy.	**Unit - IV Indirect use of Solar Energy** 4.1 Wind Flow - Motion of wind, variability in wind speed and its effect. Basic terminologies: Cut-in, cut-out and survival wind speeds, site selection consideration. 4.2 Wind Energy Conversion System (WECS): Types of wind turbines, components of wind turbine and its functions, Horizontal Axial Wind Turbine (HAWT), construction, working and specifications of HAWT, concept of wind form and project cycle. 4.3 Basic principles of biomass conversion, application of biomass in real world – Solid- Briquettes and pallets, manufacturing process, calorific value, advantages and limitations. Liquid – Ethanol from corn and sugarcane, production process, calorific value, advantages and limitations. Gas – Compressed Bio Gas (CBG), production process, calorific value, advantages and limitations. Case study of Laltipara Gaushala (Gwalior). India's national policy on biofuels- key objectives and features.	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit
5	TLO 5.1 State the economic, environmental, and social benefits of adopting renewable energy sources. TLO 5.2 Classify different types fuel cells and state their applications. TLO 5.3 State the various applications of OTEC. TLO 5.4 Describe the operation of geothermal power plant. TLO 5.5 Identify the components of tidal power plant. TLO 5.6 State objectives and features of key renewable energy schemes like PM-KUSUM and Mukhyamantri Saur Krushi Pump Yojana.	**Unit - V Other Renewable Energy Sources** 5.1 Need for use of new and renewable energy sources. 5.2 Hydrogen energy and fuel cell: Principle of operation, classification, advantages, limitation and application of fuel cell. 5.3 Ocean Energy - Ocean Thermal Energy Conversion (OTEC), general arrangement and working principle. 5.4 Geothermal Energy - Sources, working principle, construction and working of geothermal energy power plant, advantages, limitation & applications. 5.5 Tidal Energy - Tidal power, basic principle, construction and working of tidal power Plant. 5.6 Ministry of New and Renewable Energy (MNRE) schemes for agriculture sector in Maharashtra – Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) Scheme, Mukhyamantri Saur Krushi Pump Yojana – objectives and its salient features.	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use energy audit instruments to measure energy consumption in the workshop. LLO 1.2 Identify energy consumption patterns.	1	*Preliminary energy audit in a workshop facility (Machine Shop)	2	CO1
LLO 2.1 Prepare a list of computer peripherals including monitors, printers, scanners, etc., and other devices that consume electrical energy for the purpose of audit. LLO 2.2 Measure humidity and temperature of HVAC system and also measure lightning by lux meter. LLO 2.3 Identify energy conservation opportunities	2	Detailed energy audit for a computer laboratory.	2	CO1
LLO 3.1 Measure intensity of lighting by lux meter. LLO 3.2 Identify energy conservation opportunities	3	* Determination of the value of lux for classroom, library, workshop, cafeteria/canteen, laboratory, corridor, etc. and suggest energy conservation for the same.	2	CO2
LLO 4.1 Select the specific energy meters in different parts of the institute. LLO 4.2 Calculate the average energy consumption based on the collected baseline data. LLO 4.3 Plot CUSUM chart using data obtained in LLO 4.2.	4	Cumulative sum (CUSUM) technique to monitor the electrical energy consumptions of different energy meters used in institute.	2	CO2
LLO 5.1 Measure current, voltage and power output of the solar cells/panel. LLO 5.2 Measure power output of the solar panel at different inclination angles. LLO 5.3 Prepare the record sheet for data obtained in LLO 5.2	5	*Measurement of different parameters like voltage, ampere, and temperature of the solar module of 100 Watts at different inclination angle.	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Review the last 12 months data obtained from electricity bills for average monthly energy consumption in kilowatt-hours (kWh). LLO 6.2 Determine the Size of the Solar System. LLO 6.3 Calculate the Number of Panels LLO 6.4 Select an inverter that matches the capacity of the solar panels and is suitable for residential use. LLO 6.5 Design the mounting structure for the panels on the roof by using CAD LLO 6.6 Calculate the size and length of DC and AC cable	6	Design rooftop solar system of 1 to 5 kW for a residential house and list the components and structure required for the same	2	CO3
LLO 7.1 Select different materials for drying. LLO 7.2 Prepare a record sheet for external and internal temperature, relative humidity after every 15 min. LLO 7.3 Analyze the data collected during the drying process.	7	*Measure different parameters like temperature, relative humidity and time required in drying different materials (like grapes, raw mango, fruits, vegetables, herbs, grains, or spices) using solar dryer.	2	CO3
LLO 8.1 Select different food materials or liquids to cook, such as water, rice, vegetables, or a simple food item. LLO 8.2 Use a thermometer to measure the ambient temperature and the initial temperature of the cooking material. LLO 8.3 Use a thermometer to measure the temperature of the cooking material at regular intervals LLO 8.4 Calculate the efficiency of solar cooker.	8	* Factors affecting on the efficiency solar cooker and measure their performance under various conditions.	2	CO3
LLO 9.1 Select a location for the measurement of wind speed at various heights. LLO 9.2 Measure wind speed using given meters at different heights and locations. LLO 9.3 Plot the graph of wind speed vs. height for different locations.	9	* Measurement of wind speed at different heights and locations by using digital anemometer	2	CO4

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Collect sawdust/wooden dust/cow dung. LLO 10.2 Prepare briquettes and pallets by manually. LLO 10.3 Lay the briquettes or pellets on a drying rack or tray.	10	*Preparation of briquettes/pallets using waste saw dust/wooden dust/cow dung/ cattle dung.	2	CO4
LLO 11.1 Select a biofuels and conventional fuels for study purpose. LLO 11.2 Prepare a comparison chart.	11	Comparative analysis of biofuels with conventional fuels in terms of energy content, viscosity, flash point, combustion efficiency, calorific value, fuel density, temperature and pH value.	2	CO4
LLO 12.1 Identify different components of fuel cell.	12	*Demonstration of hydrogen fuel cell using video/animation	2	CO5
LLO 13.1 Identify different components of geothermal power plant. LLO 13.2 Prepare a report on geothermal power plant.	13	Demonstration of geothermal power plant using video/animation.	2	CO5
LLO 14.1 Identify different components of ocean thermal power plant. LLO 14.2 Prepare a report on ocean thermal power plant.	14	Demonstration of ocean thermal power plant using video/animation.	2	CO5
LLO 15.1 Identify different components of wind power plant. LLO 15.2 Prepare a report on wind power plant.	15	Demonstration of wind power plant using video/animation/visit.	2	CO4

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- NOT APPLICABLE

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Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Hand tools such as Screwdriver, Wrenches, Sockets, Pliers, Hammers, Torque Wrench, Spanners ,Pliers ,Wire Strippers, Cable Cutters & hand gloves etc.	1,2,3,4,5,6,7,8,9,10
2	Digital Clamp Meter - DC Voltage: 0- 600V, AC Voltage: 0 – 600V, Clamp Jaw Size: up to 50mm, Temperature: -50°C to 1000°C, AC Current: 0 – 1000A. Digital multimeter - DC Voltage up to 600V, AC Voltage up to 600V, DC Current up to 20A Digital Infrared Thermometer- Temperature Range -50 °C to 550 °C Lux Meter (Illuminance Meter) – Range 0 to 2,00,000 LUX Digital Humidity meter - Temperature Rage: -50 °C to 70°C, Humidity Range: 20% to 90%	1,2,3,4,5,7,8
3	Solar module up to 150 Watt, 12V, Polycrystalline	5
4	Solar dryer: - Capacity 5 to 10 kg Per Day Drying, Drying Tray 2 numbers Food, Grade Aluminum Perforated, Temperature Range - 55 to 85 deg Celsius	7
5	Solar Box Type Cooker, Temperature ranges up to 100 degrees Celsius	8
6	Digital anemometer – Air velocity 0 to 45 m/s, Temperature Range up to 50 degrees Celsius	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Energy Scenario and Audit	CO1	10	2	4	6	12
2	II	Energy Management and Conservation	CO2	10	2	4	6	12
3	III	Direct use of Solar Energy	CO3	16	2	6	12	20
4	IV	Indirect use of Solar Energy	CO4	10	2	4	6	12
5	V	Other Renewable Energy Sources	CO5	14	2	8	4	14
Grand Total				**60**	**10**	**26**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks and average of two-unit tests.

- For laboratory learning 25 Marks

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	2	3	3	2	3			
CO2	3	2	2	3	3	2	3			
CO3	3	2	3	3	3	2	3			
CO4	3	2	2	-	3	2	3			
CO5	3	-	-	-	3	-	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Chetan Singh Solanki	Renewable Energy Technologies- A Practical guide for beginners	PHI Learning Pvt. Ltd (2017) ISBN:9788120334342
2	Joshua Earnest, Tore Wizelius	Wind Power Plants and Project Development	PHI Learning Pvt. Ltd. (2017) ISBN: 978-81 203-5127-1
3	D.P.Kothari, K.C.Singal, Rakesh Ranjan	Renewable Energy Sources and Emerging Technologies	PHI Learning Pvt. Ltd (2017) ISBN: 978-81 203-4470-9
4	G.D.Rai	Non-Conventional Energy Sources	Khanna Publishers (2017) ISBN:978 8174090737
5	Bureau of Energy Efficiency	General aspects of energy management and energy audit	Bureau of Energy Efficiency, Fourth Edition 2015
6	Bureau of Energy Efficiency	Energy Efficiency in Electrical Utilities	Bureau of Energy Efficiency, Fourth Edition 2015
7	Bureau of Energy Efficiency	Energy Efficiency in Mechanical Utilities	Bureau of Energy Efficiency, Fourth Edition 2015
8	Garg H and Prakash J	Solar Energy: Fundamentals and Applications	McGraw Hill Education, New Delhi (2017) , ISBN- 978-0074636312
9	S.P. Sukhatme, Nayak J. K	Solar Energy: Principles of Thermal Collection and Storage	McGraw-Hill Education (India) (2017) ISBN:978-93-5260-711-2

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Sr.No	Author	Title	Publisher with ISBN Number
10	Dr.Dharmsena, Dr.Jaylaxmi	Applications of Green Power and Green Energy in Modern Life	Notion Press (2024) ISBN:979-8895440933

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=__co3m8nVUg&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=6	Non-concentrating solar collectors
2	https://dst.gov.in/climate-change-programme	National action plan on climate change (NAPCC)
3	https://pib.gov.in/newsite/PrintRelease.aspx?relid=154719	Need For an Integrated Energy Policy in India
4	https://beeindia.gov.in/sites/default/files/1Ch3.pdf	Energy management and audit
5	https://www.youtube.com/watch?v=mh51mAUexK4&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk	Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems
6	https://www.youtube.com/watch?v=pH03Y5KwpjU	Solar PV System & PV System Design
7	https://www.youtube.com/watch?v=L3AEXdvtIkk&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=19	Characteristics and properties of biomass
8	https://www.youtube.com/watch?v=7_1ELq9qGPo	Bio-CNG plant
9	https://mopng.gov.in/en/page/11	India's National Policy on Biofuels
10	https://mnre.gov.in/en/policies-and-regulations/schemes-and-guidelines/schemes/	Ministry of New and Renewable Energy (MNRE) schemes for agriculture sector in Maharashtra

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students