Course Code	18EEO301T	Course Name	SUSTAINABLE ENERGY	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	NIL	Co-requisite Courses	NIL	Progressive Courses	NIL
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes/Standards	NIL		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLR-1 :	Enrich the students on the basics of solar energy			
CLR-2 :	Develop the knowledge in wind energy conversion system.			
CLR-3 :	Understand the energy generation by biomass.			
CLR-4 :	Gain knowledge on ocean ,tidal energy			
CLR-5 :	Acquire knowledge in fuel cell and its types.			
CLR-6 :	Apply the concepts of renewable energy in industrial applications.			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning		
		1	2	3
		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)
CLO-1 :	Obtain in depth knowledge on solar applications.	2	80	75
CLO-2 :	Explain the concepts of wind energy conversion systems and their control.	3	80	75
CLO-3 :	Summarize the biomass technologies and calculate the power conversion of biomass digestion.	3	80	75
CLO-4 :	Interpret the environmental impacts of ocean and tidal energy	3	80	75
CLO-5 :	Summarize the working principle of fuels cells and its types.	3	80	75
CLO-6 :	Infer the knowledge about various types of renewable energy systems	3	80	75

Program Learning Outcomes (PLO)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO - 3
H	M	M	-	-	-	L	-	-	-	-	-	H	M	-
H	M	M	-	-	-	L	-	-	-	-	-	H	M	-
H	M	-	-	-	-	L	-	-	-	-	-	H	M	-
H	M	-	-	-	-	L	-	-	-	-	-	H	M	-
H	M	-	-	-	-	L	-	-	-	-	-	H	M	-
H	M	M	-	-	-	L	-	-	-	-	-	H	M	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Solar radiation	Wind energy conversion	Biogas	Ocean thermal energy conversion	Fuel Cell
	SLO-2	Beam and diffuse radiation, solar constant, earth	Principles of Wind energy conversion	Energy from Biomass	Principle of OTEC	Basics of Fuel cell
S-2	SLO-1	Sun angles,	Nature of the wind	Types of biomass	Lambert law of absorption	Components of fuel cells
	SLO-2	Calculation of angle of incidence	Factors influencing wind	Photosynthesis	OTEC power plant	Difference between batteries and fuel cell
S-3	SLO-1	Attenuation and measurement of solar radiation	Wind data and energy estimation- wind speed monitoring,	Factors affecting digestion system	Open loop system for ocean energy conversion	Types of fuel cells
	SLO-2	Local solar time, derived solar angles, sunrise, sunset and day length.	Site selection	Classification of biogas plants	Closed loop system for ocean energy conversion	Ionic conductivity of fuel cell
S-4	SLO-1	Flat plate collectors, concentrating collectors	Power in the wind	Advantages and disadvantages of biogas plants	Single basin	Electronic conductivity in fuel cell
	SLO-2	Solar air heaters, types, solar driers	Betz limit	Factors affecting bio digestion	dual basin ocean energy conversion system	Principle of working of fuel cell
S-5	SLO-1	Storage of solar energy, thermal storage,	Components of a wind energy conversion system	Biomass as Renewable Energy Source	Major problems and operational experience Tidal energy	Performance characteristics of fuel cells
	SLO-2	Solar pond , solar water heaters	Torque on wind	Cofiring	Site selection of tidal power plant	Selection of fuel cells
S-6	SLO-1	Solar distillation,	Wind thrust calculations	Dry Process	Tide ,Spring tide	Fuel cell stack,

			Repowering concept			
	SLO-2	*Solar Pond*	*Horizontal Axis Wind Turbine(HAWT design consideration)*	*Photosynthesis*	*Neap tide,Tidal range .*	*fuel cell power plant*
S-7	**SLO-1**	*Solar heating & cooling of buildings,*	*Tip Speed Ratio*	*Energy forming*	*Types of Tidal power plant*	*Cross section of typical PEM fuel cell.*
	SLO-2	*Solar still, solar cooker*	*Solidity*	*Pyrolysis*	*Advantages and disadvantages of tidal power plant*	*Storage methods for fuel cells.*
S-8	**SLO-1**	*Photo voltaic. Types of PV cells ,*	*Types of generators and power converters in WECS.*	*Types of Biomass Fuels*	*Wave Energy*	*Challenges and trends in fuel cell*
	SLO-2	*Characteristics and working principles of PV .*	*Control schemes for power converters.*	*Biomass power plant*	*Wave Characteristics*	*Efficiency of fuel cell*
S-9	**SLO-1**	*Maximum power point tracking methods*	*Introduction to grid integration of WECS*	*Biomass cogeneration*	*Different wave energy convertors ,Saltor Duck ,*	*Applications of fuel cell.*
	SLO-2	*Net metering concepts.*	*Issues in grid integration*	*Digester design*	*Oscillating water column and dolphin types*	*Advantages and disadvantages of fuel cell.*

Learning Resources	1. *Rai ,G.D.,Non Conventional sources of Energy, Khanna Publishers ,5th Edition 2016.* 2. *Khan. B.H, "Non-Conventional Energy Resources", The McGraw Hills,2nd Edition, 2016*	3. *O'Hayre, R.P.,S. Cha, W. Colella, F.B.Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).* 4. *https://onlinecourses-archive.nptel.ac.in/.*

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 1 (10%)	
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Understand										
Level 2	Apply	*40%*	-	*40%*	-	*40%*	-	*40%*	-	*40%*	-
	Analyze										
Level 3	Evaluate	*20%*	-	*20%*	-	*20%*	-	*20%*	-	*20%*	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er.P.Velumani, TANJEDCO , velumaniyazhini@gmail.com	*1. Dr.P.DhamodHaran, IIITM, damodharan@iiitdm.ac.in*	*1. Dr.K.Saravanan, SRM IST*
2.Er.R.Ramanavasu,BAVINI,BARC, rramanavasu@igcar.gov.in	*2. Dr.S.Kumaravel , NIT Calicut,kumaravel_s@nitc.ac.in*	*2. Dr.R.Sridhar, SRM IST*