CALICUT UNIVERSITY – FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc PHYSICS HONOURS

Programme	**B.Sc. Physics Honours**				
Course Title	**NON-CONVENTIONAL ENERGY SOURCES**				
Type of Course	**Minor (SET V: ENERGY PHYSICS)**				
Semester	**I**				
Academic Level	**100 - 109**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of different forms of energy.				
Course Summary	This course provides a comprehensive introduction to various renewable energy resources with a focus on non-conventional sources. Students will explore the principles, technologies, advantages, disadvantages, and practical applications of solar, wind, geothermal, ocean, and biomass energy.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Develop a foundational understanding of energy resources, focusing on non-conventional sources such as solar energy, and	U	C	Instructor-created exams / Quiz

	grasp key terms and concepts including solar constant, radiation measurements, collectors, and practical applications of solar power.			
CO2	Discover wind energy comprehensively, covering utilization, advantages, disadvantages, environmental impact, sources, conversion principles, components, pros and cons, wind-electric power plants, economics, and operational challenges of large generators.	Ap	P	Practical Assignment / Observation of Practical Skills
CO3	Gain insight into geothermal energy, exploring Earth's interior structure, geothermal systems like hot springs and various resources, and understanding the advantages, disadvantages, and applications of geothermal energy in comparison to other forms.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Explore ocean energy, focusing on tidal and wave energy, understanding tidal power plant components, economic aspects, OTEC working principles, efficiency, types, and applications, considering advantages and disadvantages.	U	C	Instructor-created exams / Home Assignments
CO5	Understand biomass with its resources and conversion	Ap	P	Writing assignments

	processes, explore biogas applications and plants			
CO6	Study fuel cells, hydrogen energy, government schemes, and subsidies, and conduct plant visits for performance analysis.	Ap	P	Seminar Presentation /Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		**SOLAR ENERGY**	**10**	**20**
	1	Introduction to Energy Resources-Non Conventional Energy Sources-Renewable and Non-Renewable energy sources.	1	
	2	Measurement of Solar radiation, Principles of the conversion of solar energy into heat. Collection systems, Characteristic features of a collecting system,	2	
	3	Types of collectors, Flat - Plate collectors, Selective absorber coatings/surfaces, Advantages Disadvantages and applications of flat plate collectors.	2	
	4	Concentrating collectors (Performance analysis not needed) ,Solar air heaters and drying, solar cooking, solar furnaces,	2	
	5.	Solar greenhouses and global warming, solar power plants, Solar photovoltaic cells (no need of mathematical equations)	3	

	Sections 1.3, 1.4, 1.5, 2.2.1, 2.2.2, 2.3, 3.1.3 - 3.1.5, 3.2, 3.3.1 - 3.3.3. 3.4 - (excluding 3.4.11), 4.16, 4.17, 4.18, 4.19, 4.20, 4.21.4, Book 1			
II	**Wind Energy**		**9**	**18**
	6	Introduction, Utilisation aspects of wind energy, Characteristics of wind,	2	
	7	Advantages and Disadvantages of wind energy, Environmental impact of wind energy, Sources/Origins of wind	2	
	8	Principle of wind energy conversion and wind power, Basic components of wind energy conversion system(WECS)	3	
	9	Advantages and Disadvantages of WECS, Wind-Electric Generating Power Plant	1	
	10	Problems in operating large wind power generators.	1	
	Sections 5.1-5.6, 5.8, 5.10, 5.11, 5.20, 5.26, Book 1			
III	**Geo Thermal Energy, Fuel Cells**		**11**	**16**
	11	Introduction to Geothermal energy, Important aspects of Geothermal Energy, Structure of Earth's interior, Geothermal system-Hot Spring structure,	2	
	12	Geothermal Resources -Hydrothermal, Geopressured	3	
	13	Geothermal Resources - Petro-thermal system, Magma Resources	3	
	14	Advantages and disadvantages of geothermal energy over other energy forms, application of geothermal energy	2	
	15	Fuel cells, Advantages, Disadvantages and applications of fuel cells, Hydrogen energy, properties of hydrogen, Advantages of Hydrogen as a fuel.	3	
	Sections 7.1, 7.2, 7.3, 7.5, 7.8.1, 7.8.2, 7.8.3, 7.8.4, 7.9, 7.10, , 9.7.1, 9.7.2, 9.7.3, 10.1, 10.2, 10.3, Book 1			

IV	**Energy from Ocean and Biomass**		**15**	**16**
	16	Ocean Energy, Ocean Energy Sources, Tidal energy	2	
	17	Components of a Tidal Power Plant, Advantages and disadvantages of tidal power, Economic aspects of tidal energy conversion,	2	
	18	Wave energy, Advantages and disadvantages, Factors affecting Wave energy	2	
	19	Ocean Thermal Energy Conversion (OTEC), Working principle of OTEC, Efficiency of OTEC, Closed cycle system, open cycle system, Advantages, Disadvantages and applications of OTEC	2	
	20	Ocean Energy, Ocean Energy Sources, Tidal energy	2	
	21	Introduction to biomass, Biomass resources, Biomass conversion process and applications	2	
	22	Biogas, Biogas applications, biogas plants, Raw materials used in biogas plants, Main components of a biogas plant,	3	
	Sections 8.1, 8.2, 8.3.1, 8.3.8, 8.3.14, 8.4.1, 8.4.2, 8.4.3, 8.5.1, 8.5.3, 8.5.4, 8.5.5.1,8.5.5.2, 8.5.5.5, 8.5.6, 6.1, 6.2, 6.5, 6.6.1,6.6.2, 6.7.1, 6.7.2 , 6.7.3, Book 1			
V	**PRACTICALS**		**30**	
	Conduct any 5 experiments from the given list and 1 additional experiment, decided by the teacher-in-charge, related to the content of the course. The 6th experiment may also be selected from the given list. Necessary theory of experiments can be given as Assignment/ Seminar.			
	1	**Energy audit of home/institution** • Estimate the energy use, identify the areas where energy is wasted and identify areas of improvement.		
	2	**Study power output of solar cell.**		

		• Plot the V-I characteristics of solar cell under dark and illuminated conditions and get the open circuit voltage and short circuit current. • Plot voltage-power graph and get the maximum output power point. • Optional: find the efficiency of the solar cell, if a standardized light source is available. • ExpEYES may be used. Solar cell of voltage rating 3V and current rating of the order of 100mA is desirable for the study. • https://expeyes.in/experiments/electronics/diodeIV.html		
	3	**Study the characteristics of LDR.** • Measure the dark resistance of LDR • Place LDR at different distances from an electric lamp and measure its resistance. Plot light intensity($E \alpha \frac{1}{r^2}$) vs LDR resistance. • Optional: Construct a dark sensor using LDR and transistor. In order to turn on the LED in the desired light intensity, an adjustable resistor can be used in the circuit.		
	4	**Construction of the center tapped full wave rectifiers and regulated power supply.** • Construct a center tapped full wave rectifier without filter and with a filter. • Measure the AC and DC voltages using a multimeter and calculate the ripple factor without and with a filter. • Observe the variation of the ripple factor with load resistance, when filter is used. • Construct 5V/12V regulated power supply using 78XX IC.		
	5	**Black body spectrum of Sun -Estimation of surface temperature using the Tracker Video Analysis tool.** • Calibrate the video of the solar spectra in the Tracker tool using two laser wavelengths/lines of mercury spectra. • Plot wavelength vs intensity, get • λ_{max} and using Wein's law calculate the surface temperature. • Pre recorded video of the solar spectra can be used. • https://physlets.org/tracker/. • https://www.youtube.com/watch?v=UCCPkJpUQEw		

	6	**Acceleration of a Freely Falling Body** ● Use the smartphone acoustic stopwatch to determine the duration of a free fall. ● Measure the time of flight of a steel ball for different heights and plot a graph of distance vs. time squared (s vs. t^2). Determine g from the graph. ● Experiment 2 of Book 4. ● Phyphox app may be used. https://phyphox.org/experiment/free-fall-2/ **OR** ● Use ExpEyes kit, electromagnet, and contact sensor to determine the duration of a free fall. https://expeyes.in/experiments/mechanics/tof.html		
	7	**Analysis of Bouncing Balls to Determine Gravitational Acceleration and Coefficient of Restitution.** ● After doing the experiment, the student should be able to understand the concept of inelastic collision. ● Measure the time interval between successive bounces using a digital acoustic stopwatch and hence calculate g and coefficient of restitution ● Experiment 12 of Book 4 ● Phyphox app may be used. https://phyphox.org/experiment/inelastic-collision/		
	8	**The Nearly Parabolic Trajectories of a Bouncing Ball** ● Perform Experiment 7 using Tracker tool. ● Track the ball and plot the time Vs position graph. ● Measure the time interval between successive bounces and hence calculate g and coefficient of restitution. ● Experiment 12 of Book 4 ● https://www.youtube.com/watch?v=ocLQFMMLIGw		
	9	**Analysis of Air Resistance and Terminal Speed to Determine the Drag Coefficient.** ● Record the motion of a light weight paper cup and analyse it with Tracker tool (https://physlets.org/tracker/). ● Plot acceleration, velocity, and position with time. ● Repeat the experiment with different mass (by simply stacking the paper cups)		

		• Determine the Drag Coefficient • Experiment 27 of Book 4. • https://www.youtube.com/watch?v=iujzK3uH1Yc		
	10	**Projectile Motion: Kinematics** • Analyse projectile motion as a combination of horizontal motion with constant velocity and vertical motion with constant acceleration. • Drop two balls from a height, one from rest, and other simultaneously projected horizontally. • Analyse the motion of both in the Tracker tool. • https://www.youtube.com/watch?v=zMF4CD7i3hg • https://www.youtube.com/watch?v=Mi01anodoDE • https://www.youtube.com/watch?v=5I0NLNthJGc		
	11	**Projectile Motion: Energy Conservation** • Analyse the motion of the tossing ball/ projectile in the Tracker tool. • Plot time Vs the x-and y-components of velocity and acceleration. • Also plot the kinetic energy, potential energy (build data using define tool) and total energy. • https://www.youtube.com/watch?v=x0AWRLvgB28 • https://www.youtube.com/watch?v=i07HeUWo8xc		
	12	**Verification of Faraday's law and Lenz's law of electromagnetic induction** • Verify Faraday's law and Lenz's law by measuring the induced voltage across a coil subjected to the varying magnetic field. • Galvanometer/ExpEYES can be used to measure the induced emf. • In the third experiment, for better coupling between the coils, use a high permeability material like iron or ferrite core, and observe the change in the induced emf. • https://expeyes.in/experiments/school-level/mutual-induction.html • Simulation: https://phet.colorado.edu/sims/html/faradays-law/latest/faradays-law_all.html		

	13	**Analysis of induced emf developed in a coil as a magnet dropping through it.** • Drop a neodymium magnet through a coil, guided through a vertical tube. • Repeat the experiment by dropping the magnet, through different heights from the coil and by changing the approaching pole. • Capture the induced emf as a function of time using ExpEYES, note the maximum value of the emf and verify Faraday's law and Lenz's law of induced emf and flux change. • https://expeyes.in/experiments/school-level/em-induction.html		
	14	**AC three phase generator.** • Rotate a neodymium magnet about an axis perpendicular to its dipole axis and fix three coils displaced equally from each other, i.e., 120^o separated. • Analyze the induced emf developed in the coils using CRO/ExpEYES and the phase relationship between the three induced voltages. • Optional: Realize star connection (three phase four wire system) and verify the p.d. between the wires. • https://expeyes.in/experiments/school-level/ac-generator.html		

Books and References:

1. Non- Conventional Energy Sources and Utilisation by R.K.Rajput, S.Chand Publishers, 1st Edition (Book 1)
2. Nonconventional energy resources by G. D. Rai, Khanna publishers-2008 (Book 2)
3. Solar Energy by S. B. Sukhatme-Tata McGraw-Hill Publishing Company Ltd - 1997 (Book 3)
4. Smartphones as Mobile Minilabs in Physics(Edn. 1) by Jochen Kuhn & Patrik Vogt, Springer, (Book 4)

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	2	1	1	0	2	1	2	0	0	1	1	0	0
CO 2	2	1	1	0	2	1	2	0	0	1	1	0	0
CO 3	2	2	2	0	2	1	2	0	0	1	1	0	0