# University of Kerala

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| Discipline | **PHYSICS** | | | | |
| Course Code | **UK3VACPHY200** | | | | |
| Course Title | **ENERGY CRISIS, SUSTAINABILITY AND MANAGEMENT** | | | | |
| Type of Course | **VAC** | | | | |
| Semester | **III** | | | | |
| Academic Level | **200 - 299** | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 3 | 3 Hrs | - | - | 3 Hrs |
| Pre-requisites | | | | | |
| Course Summary | This course provides a comprehensive understanding of the historical context, current challenges, and future prospects of global energy consumption and production. Upon completion of the course, graduates will be equipped with the knowledge and skills to analyze energy systems, evaluate sustainability measures, and contribute to informed decision-making in the energy sector | | | | |

**BOOKS FOR REFERENCE:**

1. World Issues - Energy Crisis, S Chand Publishing, ISBN : 9788121933391
2. Understanding the Global energy crisis, Edited by Eugene D. Coyle and Richard A. Simmons, ISBIN: 978-1-55753-661-7, Purdue University Press, USA

**DETAILED SYLLABUS: THEORY**

| Module | Unit | Content | Hrs | CO No |
|---|---|---|---|---|
| **I** | **Global energy demand** | | **7** | **1** |
| | 1 | Energy demand before industrial revolution | 1 | 1 |

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|---|---|---|---|---|
| | 2 | Energy sources in 19th century | 2 | 1 |
| | 3 | Growth of energy demand and sources in 20th century | 2 | 1 |
| | 4 | Energy demand and gross national product | 2 | 1 |
| **II** | **Fuel crisis - coal and oil** | | **7** | |
| | 5 | Oil crisis; Oil extraction, reserves,<br>Oil types- Shale, Heavy and Tar Sands, Environmental Issues | 2 | 2 |
| | 6 | Coal: Production, reserves, mining, Environmental Issues | 3 | 2 |
| | 7 | Disinvestment from fossil fuels and rise in oil prices | 2 | 2 |
| **III** | **Renewable Energy sources** | | **11** | |
| | 8 | Solar Energy | 2 | 3 |
| | 9 | Wind Energy | 2 | 3 |
| | 10 | OCEAN and WAVE ENERGY; Tidal Power, Wave, Ocean Thermal Energy Conversions, Future and Scope | 3 | 3 |
| | 11 | Scope of Geothermal energy | 2 | 3 |
| | 12 | Hydroelectric energy, hydroelectric generation, future of hydroelectric energy (Environmental and economical viability) | 2 | 3 |
| **IV** | **Policies and planning** | | **11** | |
| | 13 | Energy supply and investment planning | 3 | 4 |
| | 14 | Future GDP/Energy consumption ratio | 3 | 4 |
| | 15 | Future energy options for developing nations | 3 | 4 |
| | 16 | Global energy politics and policies | 1 | 4 |
| | 17 | India: Energy and Climate Change Policies | 1 | 4 |
| **V*** | **Energy Options for the Future** | | **9** | |
| | 18 | Hydrogen and Fuel Cells ( Brief description of its Design, working, advantages and disadvantages) | 4 | 5 |
| | 19 | Future Energy storage options : An introduction on<br>Thermal energy storage systems<br>Mechanical energy storage systems<br>Chemical energy storage systems<br>Electrochemical energy storage systems<br>Solar energy storage storage systems | 5 | 5 |

## COURSE OUTCOMES

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand the historical context of energy consumption prior to the Industrial Revolution. Identify the primary sources of energy utilized before the Industrial Revolution and their limitations. Examine the transition from traditional biomass fuels to fossil fuels during the 19th century.Identify key developments in coal, oil, and natural gas extraction and utilization during the 19th century.Trace the exponential growth of global energy demand throughout the 20th century.<br>Explore the relationship between energy demand and economic growth, as measured by Gross National Product (GNP). | U | PSO-1 |
| CO-2 | Understand the historical context, causes, and consequences of oil crises on global economies and energy policies. Analyze techniques, challenges, and geopolitical implications of oil extraction and reserve estimation. Examine characteristics, extraction methods, and environmental impacts of Shale, Heavy, and Tar Sands. Evaluate the ecological consequences and mitigation strategies for environmental issues associated with oil extraction and use. Explore global coal production trends, reserves distribution, and environmental impacts of coal mining and combustion. Explore future implications of divestment movements and their relationship to oil price dynamics. | U, Ap, An | PSO-1,3 |
| CO-3 | Understand the principles of solar energy conversion and its significance in renewable energy systems. Discuss the different types of solar technologies, including photovoltaic (PV) and concentrating solar power (CSP), and their applications. Evaluate the environmental and economic benefits and challenges associated with solar energy deployment. Understand the fundamental principles of wind energy generation and its importance as a renewable energy resource. Analyse different wind turbine technologies, including horizontal-axis and vertical-axis turbines, and their operational characteristics. Understand the challenges and opportunities for expanding wind energy .Understand the various | U, Ap, An | PSO-1,3 |

| | | | |
|---|---|---|---|
| | forms of ocean energy, including tidal power, wave energy, and ocean thermal energy conversion (OTEC), and their potential for electricity generation. Explore the principles of geothermal energy extraction and its potential as a renewable heat and power source. Understand the basic principles of hydroelectric power generation. Evaluate the environmental and socio-economic impacts of hydroelectric projects, including habitat disruption and resettlement issues. Discuss the challenges and opportunities for expanding hydroelectric capacity | | |
| CO-4 | Understand the principles and methodologies involved in strategic energy supply planning and investment decision-making. Analyze the evolving relationship between economic growth (GDP) and energy consumption, and its implications for sustainability and development. Evaluate the potential energy pathways and policy frameworks for sustainable development in developing nations, considering socio-economic contexts and environmental concerns. Examine the interplay of geopolitical factors, international relations, and policy initiatives in shaping global energy landscapes and addressing energy security challenges. Explore India's energy sector dynamics, climate change mitigation efforts, and policy strategies aimed at promoting energy security, sustainability, and economic growth. | U, Ap,E, C | PSO-1,3 |
| CO-5 | Understand the design, working principles, advantages, and disadvantages of hydrogen-based fuel cell technologies. Introduce the concepts and applications of various energy storage systems, including thermal, mechanical, chemical, and electrochemical technologies, as well as solar energy storage solutions | Ap, C | PSO-1,3 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

**Name of the Course: ENERGY CRISIS, SUSTAINABILITY AND MANAGEMENT**

**Credits: 3:0:0 (Lecture: Tutorial: Practical)**

| CO No. | CO | PO / PSO | Cognitive Level | Knowledge Category | Lecture (L)/ Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand the historical context of energy consumption prior to the Industrial Revolution. Identify the primary sources of energy utilized before the Industrial Revolution and their limitations. Examine the transition from traditional biomass fuels to fossil fuels during the 19th century.Identify key developments in coal, oil, and natural gas extraction and utilization during the 19th century.Trace the exponential growth of global energy demand throughout the 20th century. Explore the relationship between energy demand and economic growth, as measured by Gross National Product (GNP). | PO1,3,4,7/ PSO-1 | U | F | L/T | - |
| CO-2 | Understand the historical context, causes, and consequences of oil crises on global economies and energy policies. Analyze techniques, challenges, and geopolitical implications of oil extraction and reserve estimation. Examine characteristics, extraction methods, and environmental impacts of Shale, Heavy, and Tar Sands. Evaluate the | PO1,3,4,5,7,8/ PSO-1,3 | U, Ap, An | F | L | - |

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| | ecological consequences and mitigation strategies for environmental issues associated with oil extraction and use. Explore global coal production trends, reserves distribution, and environmental impacts of coal mining and combustion. Explore future implications of divestment movements and their relationship to oil price dynamics. | | | | | |
| CO-3 | Understand the principles of solar energy conversion and its significance in renewable energy systems. Discuss the different types of solar technologies, including photovoltaic (PV) and concentrating solar power (CSP), and their applications. Evaluate the environmental and economic benefits and challenges associated with solar energy deployment. Understand the fundamental principles of wind energy generation and its importance as a renewable energy resource. Analyse different wind turbine technologies, including horizontal-axis and vertical-axis turbines, and their operational characteristics. Understand the challenges and opportunities for expanding wind energy .Understand the various forms | PO1,3 ,4,5,7, 8/ PSO-1,3 | U, Ap, An | F, C,P | L | - |

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|---|---|---|---|---|---|---|
| | of ocean energy, including tidal power, wave energy, and ocean thermal energy conversion (OTEC), and their potential for electricity generation. Explore the principles of geothermal energy extraction and its potential as a renewable heat and power source. Understand the basic principles of hydroelectric power generation. Evaluate the environmental and socio-economic impacts of hydroelectric projects, including habitat disruption and resettlement issues. Discuss the challenges and opportunities for expanding hydroelectric capacity | | | | | |
| CO-4 | Understand the principles and methodologies involved in strategic energy supply planning and investment decision-making. Analyze the evolving relationship between economic growth (GDP) and energy consumption, and its implications for sustainability and development. Evaluate the potential energy pathways and policy frameworks for sustainable development in developing nations, considering socio-economic contexts and environmental concerns. | PO1,3,4,7,8/ PSO-1,3 | U, Ap, E | F, C,P | L/T | - |

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| | Examine the interplay of geopolitical factors, international relations, and policy initiatives in shaping global energy landscapes and addressing energy security challenges. Explore India's energy sector dynamics, climate change mitigation efforts, and policy strategies aimed at promoting energy security, sustainability, and economic growth. | | | | | |
| CO-5 | Understand the design, working principles, advantages, and disadvantages of hydrogen-based fuel cell technologies. Introduce the concepts and applications of various energy storage systems, including thermal, mechanical, chemical, and electrochemical technologies, as well as solar energy storage solutions | PO1,3 ,4,7/ PSO-1,3 | Ap | F, C,P | L/T | - |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

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

| | **PSO 1** | **PSO 2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PSO 7** | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | 1 | - | - | - | - | - | - | 2 | - | 2 | 2 | - | - | 3 | - |
| CO-2 | 1 | - | 1 | - | - | - | - | 2 | - | 3 | 2 | 1 | - | 1 | 2 |
| CO-3 | 1 | - | 1 | - | - | - | - | 2 | - | 1 | 2 | 3 | - | 2 | 2 |
| CO-4 | 1 | - | 1 | - | - | - | - | 2 | - | 1 | 2 | - | - | 2 | 3 |
| CO-5 | 1 | - | 1 | - | - | - | - | 2 | - | 2 | 2 | - | - | 2 | - |

**Correlation Levels:**

| **Level** | **-** | **1** | **2** | **3** |
|---|---|---|---|---|
| **Correlation** | **Nil** | **Slightly / Low** | **Moderate / Medium** | **Substantial / High** |

**Assessment Rubrics:**

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

**Mapping of COs to Assessment Rubrics :**

| CO No | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO-1 | ✓ | - | - | ✓ |
| CO-2 | ✓ | - | - | ✓ |
| CO-3 | ✓ | - | - | ✓ |
| CO-4 | ✓ | ✓ | ✓ | ✓ |
| CO-5 | ✓ | ✓ | - | - |