SRM VALLIAMMAI ENGINEERING COLLEGE

(An autonomous Institution)

SRM Nagar, Kattankulathur – 603203

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M.E. POWER SYSTEMS ENGINEERING

QUESTION BANK

Academic Year 2024-2025 EVEN

PPS105- RENEWABLE ENERGY AND GRID INTEGRATION

(Regulation 2023)

Prepared By

Ms.R.Elavarasi / Assistant Professor-(O.G)

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603203

Department of Electrical and Electronics Engineering

QUESTIONBANK

SUBJECT: PPS105- RENEWABLE ENERGY AND GRID INTEGRATION

SEM / YEAR : II / I- Academic Year 2024–2025 EVEN

UNITI –INTRODUCTION				
Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy penetration to grid. Grid Codes in India and other countries. Basic power electronic converters for renewable energy integration to grid- Qualitative analysis -Boost and buck-boost converters, three phase AC voltage controllers- AC-DC-AC converters, PWM Inverters, Grid Interactive Inverters-matrix converters.				
PART–A				
Q. No	**Questions**	**BT Level**	**Competence**	**Course Outcome**
1.	Define renewable energy systems and provide examples.	BTL-1	Remembering	CO 1
2.	Explain the importance of considering environmental aspects in electric energy conversion.	BTL-2	Understanding	CO 1
3.	Discuss two environmental benefits of renewable energy compared to fossil fuels.	BTL-2	Understanding	CO 1
4.	How does the intermittent nature of renewable energy sources impact grid stability?	BTL-2	Understanding	CO 1
5.	List two grid stability issues associated with the integration of renewable energy.	BTL-1	Remembering	CO 1
6.	What are grid codes, and why are they important for renewable energy integration?	BTL-2	Understanding	CO 1
7.	Provide examples of grid codes related to renewable energy in India.	BTL-1	Remembering	CO 1
8.	Explain the purpose of grid codes in ensuring safe and reliable grid operation.	BTL-2	Understanding	CO 1
9.	What role do power electronic converters play in integrating renewable energy into the grid?	BTL-2	Understanding	CO 1
10.	Describe the function of a boost converter in renewable energy systems.	BTL-2	Understanding	CO 1
11.	How does a buck-boost converter differ from a boost converter?	BTL-2	Understanding	CO 1
12.	Discuss the significance of three-phase AC voltage controllers in grid-connected renewable energy systems.	BTL-2	Understanding	CO 1

13.	Explain the operation of an AC-DC-AC converter in renewable energy integration.	BTL-2	Understanding	CO 1
14.	What is PWM modulation, and how is it used in inverters for renewable energy systems?	BTL-2	Understanding	CO 1
15.	Describe the functionality of grid-interactive inverters in renewable energy applications.	BTL-2	Understanding	CO 1
16.	What are the advantages of matrix converters compared to traditional inverters?	BTL-2	Understanding	CO 1
17.	How do matrix converters contribute to improving power quality in renewable energy systems?	BTL-2	Understanding	CO 1
18.	Discuss two challenges associated with the environmental impact of electric energy conversion.	BTL-4	Analyzing	CO 1
19.	Explain how renewable energy penetration affects the overall reliability of the grid.	BTL-2	Understanding	CO 1
20.	Describe the concept of fault ride-through capability in the context of grid-connected renewable energy.	BTL-5	Evaluating	CO 1
21.	Identify two key parameters regulated by grid codes for renewable energy integration.	BTL-1	Remembering	CO 1
22.	Compare and contrast the environmental footprint of renewable energy systems with conventional power plants.	BTL-4	Analyzing	CO 1
23.	Discuss the potential role of energy storage systems in mitigating the impacts of renewable energy integration on the grid.	BTL-4	Analyzing	CO 1
24.	How do grid codes vary between different countries in terms of renewable energy integration requirements?	BTL-4	Analyzing	CO 1
	PART–B			
1.	Define renewable energy systems and discuss their significance.	BTL-1	Remembering	CO 1
2.	Explain the importance of considering environmental aspects in electric energy conversion.	BTL-2	Understanding	CO 1
3.	Identify two environmental benefits of renewable energy compared to fossil fuels.	BTL-2	Understanding	CO 1
4.	Discuss the impact of the intermittent nature of renewable energy sources on grid stability.	BTL-2	Understanding	CO 1
5.	List two grid stability issues associated with the integration of renewable energy.	BTL-1	Remembering	CO 1
6.	Describe the importance of grid codes in renewable energy integration.	BTL-2	Understanding	CO 1
7.	Provide examples of grid codes related to renewable energy in India.	BTL-3	Applying	CO 1
8.	Explain the purpose of grid codes in ensuring safe and reliable grid operation.	BTL-2	Understanding	CO 1

9.	Discuss the role of power electronic converters in integrating renewable energy into the grid.	BTL-2	Understanding	CO 1
10.	Describe the function of a boost converter in renewable energy systems.	BTL-2	Understanding	CO 1
11.	Compare and contrast a buck-boost converter with a boost converter.	BTL-2	Understanding	CO 1
12.	Discuss the significance of three-phase AC voltage controllers in grid-connected renewable energy systems.	BTL-2	Understanding	CO 1
13.	Explain the operation of an AC-DC-AC converter in renewable energy integration.	BTL-2	Understanding	CO 1
14.	Define PWM modulation and its application in inverters for renewable energy.	BTL-1	Remembering	CO 1
15.	Describe the functionality of grid-interactive inverters in renewable energy applications.	BTL-1	Remembering	CO 1
16.	Analyze the advantages of matrix converters compared to traditional inverters.	BTL-4	Analyzing	CO 1
17.	Evaluate how matrix converters contribute to improving power quality in renewable energy systems.	BTL-5	Evaluating	CO 1

UNIT - II PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS

Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect, Stand- alone PV system, Grid connected PV system, Design of PV system-load calculation, array sizing, selection of converter/inverter, battery sizing.

PART–A

Q. No	Questions	BT Level	Competence	Course Outcome
1.	Define the Photo Voltaic (PV) effect and its significance in solar energy conversion.	BTL-2	Understanding	CO 2
2.	Explain the structure and functioning of a solar cell.	BTL-2	Understanding	CO 2
3.	Name two types of solar cells and highlight their differences.	BTL-1	Remembering	CO 2
4.	Describe the equivalent circuit of a PV cell and its components.	BTL-2	Understanding	CO 2
5.	Discuss the characteristics of a PV cell concerning variations in insolation.	BTL-2	Understanding	CO 2
6.	Explain how temperature affects the I/V and P/V characteristics of a PV cell.	BTL-2	Understanding	CO 2
7.	What is the shading effect in PV cells, and how does it impact their performance?	BTL-2	Understanding	CO 2
8.	Define a stand-alone PV system and discuss its applications.	BTL-2	Understanding	CO 2
9.	What is a grid-connected PV system, and what are its advantages?	BTL-2	Understanding	CO 2
10.	Explain the process of load calculation in the design of a PV system.	BTL-2	Understanding	CO 2
11.	How is array sizing determined in the design of a PV system?	BTL-3	Applying	CO 2

12.	Discuss the factors considered in the selection of converters or inverters for PV systems.	BTL-2	Understanding	CO 2
13.	What parameters are considered when sizing batteries for a PV system?	BTL-2	Understanding	CO 2
14.	What is the purpose of the Photo Voltaic (PV) effect in solar energy conversion?	BTL-2	Understanding	CO 2
15.	Outline the structure and function of a solar cell.	BTL-2	Understanding	CO 2
16.	Differentiate between monocrystalline and polycrystalline solar cells.	BTL-2	Understanding	CO 2
17.	Illustrate the equivalent circuit of a PV cell with its key components.	BTL-2	Understanding	CO 2
18.	Analyze the impact of insolation variations on the I/V characteristics of a PV cell.	BTL-4	Analyzing	CO 2
19.	Describe the changes in PV cell characteristics due to temperature fluctuations.	BTL-1	Remembering	CO 2
20.	Explain how shading affects the performance of PV cells.	BTL-6	Creating	CO 2
21.	Compare stand-alone PV systems with grid-connected PV systems.	BTL-3	Applying	CO 2
22.	Discuss the steps involved in load calculation for designing a PV system.	BTL-1	Remembering	CO 2
23.	What factors influence the sizing of the PV array in a solar energy system?	BTL-2	Understanding	CO 2
24.	Evaluate the criteria for selecting converters or inverters in PV system design.	BTL-4	Analyzing	CO 2
	PART–B			
1.	Explain how sunlight is converted into electricity in solar cells, and why this process is important.	BTL-1	Remembering	CO 2
2.	Describe the parts of a solar cell and how they work together to generate electricity.	BTL-4	Analyzing	CO 2
3.	Compare different types of solar cells, like monocrystalline and polycrystalline, highlighting their differences.	BTL-4	Analyzing	CO 2
4.	Draw the equivalent circuit of a solar cell and explain what each part represents.	BTL-2	Understanding	CO 2
5.	Discuss how a solar cell's performance changes with different levels of sunlight.	BTL-4	Analyzing	CO 2
6.	Explain how temperature affects the performance of solar cells.	BTL-2	Understanding	CO 2
7.	Describe what happens to solar cells when they are shaded and how this affects their output.	BTL-5	Evaluating	CO 2
8.	Compare standalone solar systems with those connected to the grid, outlining their differences.	BTL-2	Understanding	CO 2

9.	Explain how to calculate the electricity needs for a solar system.	BTL-3	Applying	CO 2
10.	Describe how to determine the size of a solar panel array for a given application.	BTL-2	Understanding	CO 2
11.	Discuss the criteria for choosing converters or inverters for solar systems.	BTL-2	Understanding	CO 2
12.	Explain how to choose the right size of batteries for a solar system.	BTL-1	Remembering	CO 2
13.	Analyze how maximum power point tracking (MPPT) algorithms improve solar system efficiency.	BTL-6	Creating	CO 2
14.	Discuss the concept of net metering and its importance in solar power systems.	BTL-1	Remembering	CO 2
15.	Evaluate the environmental impact of solar energy systems from production to disposal.	BTL-2	Understanding	CO 2
16.	Describe recent advancements in solar cell technology and their potential impacts.	BTL-3	Applying	CO 2
17.	Discuss the benefits and challenges of widespread adoption of solar energy systems.	BTL-2	Understanding	CO 2

UNIT - III WIND ENERGY CONVERSION SYSTEMS

Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind control strategies, Power curve and Operating area, Types of wind generators system based on Electrical machines- Induction Generator and Permanent Magnet Synchronous Generator(PMSG), Grid Connected-Single and Double output system, Self-excited operation of Induction Generator and Variable Speed PMSG.

PART–A

Q.No	Questions	BT Level	Competence	Course Outcome
1.	Define wind energy systems and explain why they are important.	BTL-1	Remembering	CO 3
2.	How is wind power captured to generate electricity?	BTL-4	Analyzing	CO 3
3.	What factors affect the efficiency of wind energy systems?	BTL-1	Remembering	CO 3
4.	Compare and contrast two types of wind turbines.	BTL-6	Creating	CO 3
5.	How are wind turbines managed to improve performance?	BTL-2	Understanding	CO 3
6.	Explain the purpose of a power curve in wind turbines.	BTL-2	Understanding	CO 3
7.	Describe what the operating area of a wind turbine represents.	BTL-4	Analyzing	CO 3
8.	Differentiate between induction generators and permanent magnet synchronous generators.	BTL-1	Remembering	CO 3
9.	Explain the concept of a grid-connected single output system.	BTL-1	Remembering	CO 3
10.	Discuss the operation of a grid-connected double output system.	BTL-1	Remembering	CO 3
11.	How does self-excited operation function in induction generators?	BTL-3	Applying	CO 3
12.	Describe variable-speed operation in permanent magnet synchronous generators.	BTL-5	Evaluating	CO 3

13.	List the main components of a wind energy system.	BTL-6	Creating	CO 3
14.	How does a wind turbine convert wind energy into electricity?	BTL-3	Applying	CO 3
15.	What influences the power output of a wind turbine?	BTL-4	Analyzing	CO 3
16.	Compare horizontal-axis and vertical-axis wind turbines.	BTL-2	Understanding	CO 3
17.	Why is controlling wind turbines important for energy production?	BTL-3	Applying	CO 3
18.	Explain how wind turbine power curves are used in performance assessment.	BTL-4	Analyzing	CO 3
19.	Compare the characteristics of induction generators and permanent magnet synchronous generators.	BTL-2	Understanding	CO 3
20.	What components make up a grid-connected wind energy system?	BTL-1	Remembering	CO 3
21.	Describe the role of inverters in wind energy systems.	BTL-1	Remembering	CO 3
22.	How is reactive power controlled in wind energy systems?	BTL-3	Applying	CO 3
23.	Discuss the impact of wind turbine blade design on efficiency.	BTL-4	Analyzing	CO 3
24.	How does wind farm layout affect energy production?	BTL-2	Understanding	CO 3
	PART–B			
1.	Explain why wind energy conversion systems are important for renewable energy. Discuss their impact on sustainability and global energy needs.	BTL-1	Remembering	CO 3
2.	Describe how wind turbines generate electricity from wind power. Compare different types of wind turbines and their suitability for various environments.	BTL-6	Creating	CO 3
3.	Evaluate the effectiveness of wind control strategies in maximizing energy capture and minimizing turbine downtime. Explain the significance of power curves and operating areas in wind turbine performance.	BTL-4	Analyzing	CO 3
4.	Compare induction generators and permanent magnet synchronous generators used in wind energy systems. Analyze their characteristics and applications.	BTL-5	Evaluating	CO 3
5.	Assess the role of grid-connected single output systems in wind energy conversion. Discuss their importance in maintaining grid stability and integrating renewable energy.	BTL-2	Understanding	CO 3
6.	Discuss the concept and operation of grid-connected double output systems in wind energy generation. Identify their advantages and challenges in supporting distributed energy systems.	BTL-3	Applying	CO 3
7.	Explain how self-excited operation works in induction generators used in wind energy systems. Evaluate its impact on generator stability and performance.	BTL-2	Understanding	CO 3
8.	Describe the concept of variable-speed operation in permanent magnet synchronous generators (PMSGs) for wind energy	BTL-4	Analyzing	CO 3

	conversion. Discuss its benefits and drawbacks.			
9.	Analyze the environmental, economic, and social effects of widespread wind energy adoption. Consider factors like land use, wildlife, and job creation.	BTL-2	Understanding	CO 3
10.	Discuss the challenges of integrating wind energy into the power grid. Consider issues related to grid stability, storage, and transmission infrastructure.	BTL-2	Understanding	CO 3
11.	Evaluate the contribution of wind energy to reducing greenhouse gas emissions and addressing climate change. Discuss policies and technologies driving its growth.	BTL-1	Remembering	CO 3
12.	Explain the importance of research and development in advancing wind energy technologies. Discuss efforts to overcome technical and economic barriers to adoption.	BTL-1	Remembering	CO 3
13.	Describe the basic components of a wind energy conversion system and how they work together to generate electricity.	BTL-3	Applying	CO 3
14.	Evaluate the impact of wind speed variability on wind turbine performance. Discuss strategies to mitigate the effects of variable wind conditions.	BTL-1	Remembering	CO 3
15.	Compare the advantages and disadvantages of onshore and offshore wind energy systems. What factors influence their feasibility and deployment?	BTL-3	Applying	CO 3
16.	Discuss the economic viability of wind energy compared to traditional energy sources. Consider factors such as cost, return on investment, and market competitiveness.	BTL-4	Analyzing	CO 3
17.	Evaluate the potential role of wind energy in rural electrification and off-grid power solutions. Discuss its benefits and challenges in remote and underserved areas.	BTL-2	Understanding	CO 3

UNIT - IV MPPT TECHNIQUES IN SOLAR AND WIND SYSTEMS

Case studies of PV-Maximum Power Point Tracking (MPPT) and Wind Energy system

PART–A

Q.No	Questions	BT Level	Competence	Course Outcome
1.	What does MPPT stand for, and why is it important in solar and wind energy systems?	BTL-1	Remembering	CO 4
2.	Define the Maximum Power Point (MPP) and its significance in renewable energy.	BTL-3	Applying	CO 4
3.	Name two primary components of a PV-MPPT system.	BTL-5	Evaluating	CO 4
4.	How does MPPT help maximize power output from solar panels?	BTL-2	Understanding	CO 4
5.	What are some common challenges in tracking the maximum power point in solar panels?	BTL-2	Understanding	CO 4

6.	Explain how MPPT algorithms work in solar energy systems.	BTL-2	Understanding	CO 4
7.	What factors influence the choice of MPPT technique in solar systems?	BTL-1	Remembering	CO 4
8.	Compare the perturb and observe (P&O) and incremental conductance (IncCond) MPPT algorithms.	BTL-3	Applying	CO 4
9.	Discuss one advantage and one disadvantage of the hill-climbing MPPT algorithm.	BTL-4	Analyzing	CO 4
10.	How does MPPT contribute to improving the efficiency of solar energy conversion?	BTL-1	Remembering	CO 4
11.	Can you describe a case study where MPPT improved the performance of a photovoltaic system?	BTL-4	Analyzing	CO 4
12.	What impact does shading have on MPPT effectiveness in solar systems?	BTL-3	Applying	CO 4
13.	Explain the importance of MPPT in grid-connected solar installations.	BTL-1	Remembering	CO 4
14.	Describe the role of MPPT in off-grid solar systems.	BTL-4	Analyzing	CO 4
15.	What is the role of MPPT in wind energy systems?	BTL-6	Creating	CO 4
16.	Compare MPPT techniques used in solar and wind systems.	BTL-2	Understanding	CO 4
17.	What challenges are specific to MPPT implementation in wind energy systems?	BTL-4	Analyzing	CO 4
18.	How does MPPT help maximize power generation in wind turbines?	BTL-1	Remembering	CO 4
19.	Can you discuss a case study where MPPT optimization enhanced the performance of a wind energy system?	BTL-1	Remembering	CO 4
20.	Analyze the effectiveness of different MPPT algorithms in wind energy applications.	BTL-3	Applying	CO 4
21.	Why is MPPT important in improving the overall efficiency of renewable energy systems?	BTL-1	Remembering	CO 4
22.	How does MPPT mitigate the impact of fluctuating environmental conditions on energy generation?	BTL-1	Remembering	CO 4
23.	Describe how MPPT integrates with energy storage systems in renewable energy applications.	BTL-2	Understanding	CO 4
24.	Discuss potential future trends and advancements in MPPT technology for solar and wind systems.	BTL-2	Understanding	CO 4
	PART–B			
1.	Define MPPT and its significance in solar and wind energy systems.	BTL-1	Remembering	CO 4
2.	Explain the concept of Maximum Power Point (MPP) and its importance in renewable energy systems.	BTL-4	Analyzing	CO 4
3.	Identify and describe two primary components of a PV-MPPT system.	BTL-2	Understanding	CO 4
4.	How does MPPT contribute to maximizing power output from solar panels?	BTL-5	Evaluate	CO 4
5.	Discuss common challenges encountered in tracking the maximum power point in solar panels.	BTL-3	Applying	CO 4

6.	Explain the functionality of MPPT algorithms in solar energy systems.	BTL-4	Analyzing	CO 4
7.	Analyze the factors influencing the choice of MPPT technique in solar systems.	BTL-4	Analyzing	CO 4
8.	Compare and contrast the perturb and observe (P&O) and incremental conductance (IncCond) MPPT algorithms.	BTL-2	Understanding	CO 4
9.	Discuss one advantage and one disadvantage of the hill-climbing MPPT algorithm.	BTL-1	Remembering	CO 4
10.	Describe how MPPT contributes to improving the efficiency of solar energy conversion.	BTL-1	Remembering	CO 4
11.	Can you narrate a case study demonstrating how MPPT improved the performance of a photovoltaic system?	BTL-2	Understanding	CO 4
12.	Evaluate the impact of shading on MPPT effectiveness in solar systems, citing relevant case studies.	BTL-4	Analyzing	CO 4
13.	Discuss the importance of MPPT in grid-connected solar installations, providing real-world examples.	BTL-1	Remembering	CO 4
14.	Describe the role of MPPT in off-grid solar systems, illustrating with relevant case studies.	BTL-6	Creating	CO 4
15.	Explain the role of MPPT in wind energy systems, distinguishing between various MPPT techniques.	BTL-1	Remembering	CO 4
16.	Compare and contrast MPPT techniques used in solar and wind systems, evaluating their effectiveness and limitations.	BTL-1	Remembering	CO 4
17.	Assess the challenges specific to MPPT implementation in wind energy systems, proposing solutions based on case studies.	BTL-1	Remembering	CO 4

UNIT - V HYBRID STORAGE SYSTEMS AND GRID MANAGEMENT

Energy Storage systems, Need for Hybrid Systems, Features of Hybrid Systems, Range and types of Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV)

PART-A

Q. No	Questions	BT Level	Competence	Course Outcome
1.	Explain why energy storage systems are crucial for grid management.	BTL-1	Remembering	CO 5
2.	Discuss the necessity of hybrid systems in modern grid management.	BTL-6	Creating	CO 5
3.	Identify the primary features of hybrid storage systems.	BTL-4	Analyzing	CO 5
4.	Can you name the types of hybrid systems used in renewable energy integration?	BTL-5	Evaluating	CO 5
5.	How do hybrid systems mitigate the intermittency of renewable energy sources?	BTL-1	Remembering	CO 5
6.	Describe the advantages of hybrid storage systems in managing electricity grids.	BTL-4	Analyzing	CO 5
7.	Apply hybrid storage systems to enhance grid stability.	BTL-4	Analyzing	CO 5
8.	Discuss the role of hybrid systems in integrating renewable energy into the grid.	BTL-1	Remembering	CO 5
9.	Propose a scenario where a Wind-Diesel hybrid system would be	BTL-3	Applying	CO 5

	effective.			
10.	Design a PV-Diesel hybrid system suitable for remote communities	BTL-1	Remembering	CO 5
11.	How do hybrid storage systems contribute to grid stability and reliability?	BTL-5	Evaluating	CO 5
12.	Provide an example of a situation where a Wind-PV hybrid system could be advantageous.	BTL-3	Applying	CO 5
13.	Compare and contrast Wind-Diesel, PV-Diesel, and Wind-PV hybrid systems.	BTL-6	Creating	CO 5
14.	Analyze the benefits and drawbacks of integrating hybrid storage systems into existing grids.	BTL-1	Remembering	CO 5
15.	Evaluate the effectiveness of hybrid storage systems in balancing renewable energy fluctuations.	BTL-2	Understanding	CO 5
16.	Discuss potential challenges associated with deploying hybrid storage systems in grid management.	BTL-1	Remembering	CO 5
17.	Assess the impact of hybrid storage systems on increasing renewable energy penetration.	BTL-2	Understanding	CO 5
18.	Evaluate the role of hybrid storage systems in achieving energy independence.	BTL-2	Understanding	CO 5
19.	How would you assess the economic feasibility of Wind-PV hybrid systems in rural areas?	BTL-3	Applying	CO 5
20.	Discuss the regulatory and policy frameworks needed to support hybrid storage system adoption.	BTL-2	Understanding	CO 5
21.	Name examples of hybrid systems used in grid management.	BTL-1	Remembering	CO 5
22.	Identify the primary types of hybrid systems used with renewable energy sources.	BTL-1	Remembering	CO 5
23.	Explain why hybrid systems are necessary for renewable energy integration.	BTL-2	Understanding	CO 5
24.	Recall the primary features of hybrid storage systems used in grid management.	BTL-2	Understanding	CO 5
	PART–B			
1.	Discuss the role of energy storage systems in grid management, providing examples of their applications.	BTL-4	Analyzing	CO 5
2.	Explain the significance of hybrid systems in modern grid management and how they contribute to energy sustainability.	BTL-4	Analyzing	CO 5
3.	Describe the essential features of hybrid storage systems and how they differentiate from traditional storage solutions.	BTL-5	Evaluating	CO 5
4.	Compare and contrast Wind-Diesel, PV-Diesel, and Wind-PV hybrid systems, highlighting their advantages and limitations.	BTL-1	Remembering	CO 5
5.	Design a hybrid storage system tailored to the energy needs of a remote community, considering factors like energy demand and environmental impact.	BTL-3	Applying	CO 5
6.	Develop a plan for integrating a Wind-Diesel hybrid system into an existing grid infrastructure, outlining technical requirements and potential challenges.	BTL-2	Understanding	CO 5
7.	Analyze the benefits and challenges of implementing hybrid storage systems in grid management, assessing their economic	BTL-2	Understanding	CO 5

	viability and scalability.			
8.	Evaluate the effectiveness of Wind-Diesel, PV-Diesel, and Wind-PV hybrid systems in improving grid stability and reliability, drawing insights from case studies.	BTL-3	Applying	CO 5
9.	Assess the impact of hybrid storage systems on increasing renewable energy penetration into the grid and reducing reliance on conventional fuels.	BTL-1	Remembering	CO 5
10.	Evaluate the economic feasibility of implementing hybrid storage systems in rural electrification projects, considering both initial investment and long-term benefits.	BTL-1	Remembering	CO 5
11.	Develop a comprehensive strategy for integrating hybrid storage systems into national energy policies, considering regulatory frameworks and stakeholder interests.	BTL-1	Remembering	CO 5
12.	Design an innovative hybrid storage solution to address the intermittency of renewable energy sources, incorporating advanced technologies and system integration methods.	BTL-6	Creating	CO 5
13.	Analyze case studies of successful hybrid storage system implementations, identifying key factors contributing to their scalability and replicability.	BTL-4	Analyzing	CO 5
14.	Evaluate potential challenges and risks associated with the widespread adoption of hybrid storage systems, including technological constraints and market uncertainties.	BTL-1	Remembering	CO 5
15.	Recall examples of hybrid storage systems used in grid management and explain their operational principles.	BTL-2	Understanding	CO 5
16.	Identify primary types of hybrid systems used with renewable energy sources, describing their specific applications and advantages.	BTL-2	Understanding	CO 5
17.	Explain why hybrid systems are crucial for integrating renewable energy into existing grid infrastructures, referencing sustainability principles.	BTL-4	Analyzing	CO 5

COURSE OUTCOMES:

1. Ability to relate the power generation of different renewable energy sources to grid impact and grid codes.
2. Ability to explain the design principles of solar energy management systems.
3. Ability to understand the power conversion system of wind generators.
4. Ability to analyze the different Maximum Power Point tracking Techniques.
5. Ability to build grid connected and standalone renewable energy managementsystem.