



INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500043

ELECTRICAL AND ELECTRONICS ENGINEERING

TUTORIAL QUESTION BANK

Course Title	WIND AND SOLAR ENERGY SYSTEMS				
Course Code	AEEB46				
Programme	B.Tech				
Semester	FIVE				
Course Type	Professional Elective				
Regulation	IARE - R18				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Chief Coordinator	Mr. S. Srikanth, Assistant Professor				
Course Faculty	Mr. S. Srikanth, Assistant Professor Mr. A. Srikanth, Assistant Professor				

COURSE OBJECTIVES:

The course should enable the students to	
I	The fundamental concepts of power generation and gain enough knowledge about the wind and solar energy sources.
II	The construction, principle of operation of various equipments used in power generation using wind energy.
III	The key aspects in the design and operation of photovoltaic along with solar thermal power energy systems.
IV	The various factors affecting the power quality issues in integration of renewable energy resources.

COURSE OUTCOMES:

Upon the successful completion of this course the students will be able to	
CO 1	Recall the power conversions involved in windmills/ PV Systems for production of electricity.
CO 2	Outline various components involved and their functionality in production of electricity from wind and solar power plants.

CO 3	Summarize the control schemes, environmental aspects and classification of wind energy conversion systems for reliable operation.
CO 4	Outline the characteristics of solar PV modules for design of solar arrays.
CO 5	Demonstrate the functioning of various components involved in solar thermal systems for designing commercial solar power plants.
CO 6	Develop the suitable scheme for extracting maximum power from solar PV module using MPPT algorithms.
CO 7	Utilize the power conditioners and inverters for grid synchronization and harmonic reduction in solar PV systems.
CO 8	Make use of AC voltage controllers for power factor improvement and harmonic reduction in Isolated induction generators
CO 9	Identify the power quality issues and mitigation techniques used in standalone and grid connected systems for ensuring the quality of power.
CO 10	Outline the control and protection of renewable energy systems using custom power devices for stable operation of power systems.

MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 7	3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 8	3	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 9	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 10	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-

TUTORIAL QUESTION BANK

MODULE- I				
DESIGN AND OPERATION OF WIND POWER SYSTEM				
PART - A (SHORT ANSWER QUESTIONS)				
S No	QUESTIONS	Blooms Taxonomy Level	How does this subsume the level below	Course Outcomes
1	List the important wind turbine generation installations in India	Remember	---	CO 1
2	List the types of generator used in wind power plant	Remember	---	CO 1
3	Classify the wind mills	Remember	---	CO 2
4	List the disadvantages of wind power	Remember	---	CO 2
5	Define pitch angle	Remember	---	CO 2
6	Explain vertical wind mills with neat sketch	Understand	Learner to recall the operation of wind mill. Then explain vertical axis wind mill	CO 2
7	Define constant speed constant frequency WTG unit	Remember	---	CO 3
8	List the advantages of wind power	Remember	---	CO 2
9	Define yaw control system	Remember	---	CO 3
10	Define cut in speed	Remember	---	CO 2
11	Define cut out speed	Remember	---	CO 2
12	Define angle of attack in the design of wind mill blades	Remember	---	CO 2
13	Define tip speed ratio	Remember	---	CO 2
14	Classify the vertical wind mills	Remember	---	CO 1
15	List the horizontal wind power collectors	Remember	---	CO 2
16	Explain the mechanism of production of local winds	Understand	Learner to define wind. Then explain the production of local winds	CO 2
17	Explain the operation of Induction Generator	Understand	Learner to recall the operation of induction generator used in wind mills	CO 3
18	Demonstrate the function of gear box in wind mills	Understand	Learner to recall the function of gear box used in wind mills	CO 3
19	Explain the principle of drag and lift forces	Understand	Learner to recall the principle of drag and lift used in wind mill blade movement	CO 2

20	List the advantages of odd no of blades than even no of blades in wind mills	Remember	---	CO 2
PART - B (LONG ANSWER QUESTIONS)				
1	Explain the operation of wind power plant with wind power equation	Understand	Learner to recall the operation of wind power plant. Then explain the derivation of wind power equation	CO 2
2	Explain principle operation of an induction generator which is used in wind plant	Remember	---	CO 1
3	Demonstrate the electrical layout of a typical wind farm by means of single line diagram.	Understand	Learner to recall the operation of wind power plant. Then explain the electrical layout of wind mill with block diagram	CO 2
4	Demonstrate the power coefficients of windmills and environmental aspects of wind generating station	Understand	Learner to recall the operation of wind mills. Then explain the power coefficients of wind mills	CO 3
5	Explain the pitch control and Yaw control in Wind energy plant	Understand	Learner to recall the operation of wind mills. Then explain pitch control and yaw control in wind mills.	CO 3
6	Explain permanent magnet generator and an induction generator used in wind power plants	Remember	---	CO 1
7	Demonstrate different types of generating systems for wind energy.	Remember	---	CO 1
8	Explain how the variations of wind velocity and its directions are taken care in wind energy systems	Understand	Learner to recall the variation of wind velocity. Then explain the directions taken care in wind mills	CO 2
9	Demonstrate the various components used in Wind energy system and also write the important wind energy systems in India	Understand	Learner to recall the operation of wind mills. Then explain the various components used in Wind energy system	CO 2
10	Explain the factors that determine the output power from wind energy system	Understand	Learner to recall the operation of wind mills. Then explain the factors that determine the output power coefficients of wind mills	CO 2
11	Demonstrate electrical load matching in wind power plants	Understand	Learner to recall the operation of wind mills. Then explain electrical load matching in wind power plants	CO 2
12	Illustrate the variable speed operation wind mills and list the advantages of variable speed operation	Understand	Learner to recall the operation of wind mills. Then explain variable speed operation and advantages	CO 2
13	Explain the system design features of wind power plants	Understand	Learner to recall the operation of wind mills. Then explain design features of wind mills	CO 2

14	Demonstrate the operation of maximum power operation using rotor tip-speed control scheme	Understand	Learner to recall the operation of wind mills. Then explain maximum power operation using tip speed control scheme	CO 3
15	Explain the operation of Maximum power operation using power control scheme	Understand	Learner to recall the operation of wind mills. Then explain maximum power operation power control scheme	CO 3
16	Demonstrate the site selection considerations of wind power plant	Understand	Learner to recall the operation of wind mills. Then explain site selection considerations of wind power plant	CO 3
17	Explain the various wind energy collectors used in wind power plants	Understand	Learner to recall the operation of wind mills. Then explain various wind energy collectors used in wind mills	CO 2
18	Demonstrate Forces on the blade and thrust on turbines in wind mills	Understand	Learner to recall the operation of wind mills. Then explain force equation of blade and thrust on turbines	CO 2
19	Demonstrate the maximum power equation and power coefficient of wind	Understand	Learner to recall the operation of wind mills. Then explain maximum power equation of blade and thrust on turbines	CO 2
20	Explain the system design features of wind power plant	Understand	Learner to recall the operation of wind mills. Then explain system design features of wind mills	CO 2

PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)

1	Wind at 1 standard atmospheric pressure and 15 degrees has velocity of 15m/s calculate i. The total power density in the wind turbine ii. Maximum obtainable power density iii. A reasonably obtainable power density iv. The total power v. The torque Given turbine diameter = 120m, and turbine operating speed is 40rpm at maximum efficiency	Understand	Learner to recall the operation of wind mills. Then calculate the force and torque of blades	CO 2
2	Demonstrate the system control requirements of wind mills along with control characteristics	Understand	Learner to recall the operation of wind mills. Then explain system control requirements of wind mills	CO 2
3	If a wind turbine with three blades, each 4 meters long, calculate the distance does the tip of each blade travel in one fullrevolution	Understand	Learner to recall the operation of wind mills. Then calculate the distance of each blade travel in one full revolution	CO 3
4	Explain the five regions of wind turbine speed control with speed control characteristics	Understand	Learner to recall the operation of wind mills. Then explain five	CO 3

			regions of turbine speed control in wind mills	
5	Explain the environmental aspects of wind power plants	Understand	Learner to recall the operation of wind mills. Then explain environmental aspects of wind power plants	CO 3
6	An offshore wind turbine with three 60 meter blades rotates at a leisurely 12 RPM. The wind is whipping along at 18 meters per second. Calculate the tip speed ratio for this turbine	Understand	Learner to recall the operation of wind mills. Then calculate the tip speed ratio for the turbine	CO 3
7	Wind at 1 standard atmospheric pressure and 15 degrees has velocity of 20m/s calculate i. The total power density in the wind turbine ii. Maximum obtainable power density iii. A reasonably obtainable power density iv. The total power v. The torque Given turbine diameter = 100m, and turbine operating speed is 50rpm at maximum efficiency	Understand	Learner to recall the operation of wind mills. Then calculate the force and torque of blades	CO 2
8	An offshore wind turbine with three 10 meter blades rotates at a leisurely 10 RPM. The wind is whipping along at 15 meters per second. Calculate the tip speed ratio for this turbine	Understand	Learner to recall the operation of wind mills. Then calculate the tip speed ratio for the turbine	CO 3
9	If a wind turbine with three blades, each 2 meters long, calculate the distance does the tip of each blade travel in half revolution	Understand	Learner to recall the operation of wind mills. Then calculate the distance of each blade travel in one full revolution	CO 3
10	Wind at 1 standard atmospheric pressure and 15 degrees has velocity of 30m/s calculate i. The total power density in the wind turbine ii. Maximum obtainable power density iii. A reasonably obtainable power density iv. The total power v. The torque Given turbine diameter = 80m, and turbine operating speed is 60rpm at maximum efficiency	Understand	Learner to recall the operation of wind mills. Then calculate the force and torque of blades	CO 2

MODULE-II

DESIGN AND OPERATION OF PV SYSTEM

PART - A (SHORT ANSWER QUESTIONS)

1	Define solar altitude angle	Remember	---	CO 5
2	List the drawbacks in solar energy conversion	Remember	---	CO 5

3	Classify different types of solar cells	Understand	Learner to recall the classification of solar cells	CO 4
4	List the advantages and limitations of renewable energy sources	Remember	---	CO 4
5	Classify the solar energy measuring instruments	Understand	Learner to recall the classification of solar energy measuring instruments	CO 5
6	Define maximum power point tracking (MPPT) in solar system	Remember	---	CO 6
7	Compare diffuse radiation and beam radiation	Understand	Learner to compare the diffuse radiation and beam radiation	CO 5
8	List the conventional sources of energy	Remember	---	CO 5
9	Explain the importance of solar energy in the present day energy crisis	Understand	Learner to recall the energy crisis. Then explain the importance of solar energy	CO 5
10	Explain Photovoltaic effect	Understand	Learner to recall the operation of PV cell. Then explain the photovoltaic effect	CO 4
11	Define transient stability	Remember	---	CO 5
12	Show current voltage curves of a solar cell	Remember	---	CO 4
13	Show power voltage curves of a solar cell	Remember	---	CO 4
14	Define commercial power plants	Remember	---	CO 5
15	List the photovoltaic system components	Remember	---	CO 4
16	Define open circuit voltage in solar power plant	Remember	---	CO 4
17	Define solar constant	Remember	---	CO 5
18	Define short circuit current in solar power plant	Remember	---	CO 4
19	Explain beam radiation	Understand	Learner to recall the beam radiation of sun	CO 5
20	Explain diffuse radiation	Understand	Learner to recall the diffuse radiation of sun	CO 5
PART - B (LONG ANSWER QUESTIONS)				
1	Explain instruments for measuring solar radiation and important applications of solar system	Understand	Learner to recall the solar energy measuring instruments. Then explain the operation and applications of measuring instruments	CO 5
2	Demonstrate the important differences between renewable and non-renewable source.	Understand	Learner to recall the power plant operation. Then explain the difference between renewable and non renewable source	CO 5
3	Explain beam and diffuse radiation with its	Understand	Learner to recall the solar	CO 5

	expression		radiation. Then explains beam and diffuse radiation with its equation	
4	Explain the working of a Pyranometer	Understand	Learner to recall and explain the operation of pyranometer	CO 5
5	Explain operation of solar grid with block diagram	Understand	Learner to recall the operation of solar plant. Then explain the solar grid operation with block diagram	CO 5
6	Identify the Maximum power point techniques used in Solar System and how this technique improves system efficiency	Apply	Learner to recall the operation of solar plant. Then explain maximum power point techniques used in solar system	CO 6
7	Explain why it is necessary to develop non-conventional method of generating Electrical energy	Understand	Learner to recall the operation of power plant. Then explain the need to develop non-conventional energy generation	CO 5
8	Illustrate the important advantages of renewable and non-renewable energy sources.	Understand	Learner to recall the operation of solar plant. Then explain the advantages of renewable and non-renewable energy sources	CO 5
9	Demonstrate the Photovoltaic effect, semiconducting materials, band gap theory and photo emission of electrons in solar system	Understand	Learner to recall the operation of solar plant. Then explain the photovoltaic effect and band gap theory	CO 4
10	Demonstrate the construction and working of Liquid flat plate collector with a neat sketch. Explain the various parameters that affect the performance of collector	Understand	Learner to recall the operation of liquid flat plate collector. Then explain the parameters that affect the performance of collector	CO 5
11	Explain the electrical equivalent circuit of photovoltaic cell with neat diagram	Understand	Learner to recall the operation of PV cell. Then explain the equivalent circuit of PV cell	CO 5
12	Demonstrate the open circuit voltage and short circuit current of PV system	Understand	Learner to recall the operation of PV system. Then explain the open circuit voltage and short circuit current of PV system	CO 4
13	Illustrate PV system components with neat block diagram	Understand	Learner to recall the operation of PV system. Then explain the PV system components with block diagram	CO 4
14	Explain the operation of synchronous generator with electrical equivalent circuit	Understand	Learner to recall the operation of synchronous generator. Then explain the equivalent circuit of synchronous generator	CO 5
15	Demonstrate the excitation methods of synchronous generator	Understand	Learner to recall the operation of synchronous generator. Then explain the excitation methods of synchronous generator	CO 5

16	Demonstrate the photovoltaic cell, module and array in solar power plant	Understand	Learner to recall the operation of PV system. Then explain the PV cell designs	CO 4
17	Explain the factors of short-circuit current in PV system	Understand	Learner to recall the operation of PV system. Then explain the factors of short circuit current in PV system	CO 4
18	Demonstrate the different solar energy collectors used in solar power plant	Understand	Learner to recall the operation of PV system. Then explain different solar energy collectors	CO 5
19	Demonstrate the transient stability of synchronous generator	Understand	Learner to recall the operation of synchronous generator. Then explain the transient stability of synchronous generator	CO 5
20	Explain the working of a Pyrheliometer	Understand	Learner to recall and explain the operation of Pyrheliometer	CO 5

PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)

1	Demonstrate the solar thermal power plant with heliostat with center receiver focusing	Understand	Learner to recall the operation of solar thermal plant. Then explain the solar thermal power plant with heliostat with center receiver focusing	CO 5
2	Explain the overview of different types of solar radiation data with neat block diagram.	Understand	Learner to recall the operation of solar plant. Then explain the overview of different types of solar radiation data with neat block diagram	CO 5
3	Demonstrate the operation of photoelectric sunshine recorder.	Understand	Learner to recall the radiation of solar energy. Then explain the operation of photoelectric sunshine recorder	CO 5
4	Explain the different types of electrical methods of extracting the peak power from a PV source	Understand	Learner to recall the radiation of solar energy. Then explain the different types of electrical methods of extracting the peak power from a PV source	CO 4
5	Demonstrate the operation of solar GRID connected inverter	Understand	Learner to recall the operation of solar plant. Then explain the operation of solar GRID connected inverter	CO 5
6	Demonstrate the construction and operation of PV cell along with its electrical equivalent circuit diagram	Understand	Learner to recall the operation of PV system. Then explain the construction and operation of PV cell along with its electrical equivalent circuit diagram	CO 4
7	Explain the power equation of a synchronous generator using phasor diagram	Understand	Learner to recall the operation of synchronous generator. Then explain the power equation of a synchronous generator using phasor diagram	CO 5

8	Demonstrate the transient stability limits of synchronous generator with neat diagram	Understand	Learner to recall the operation of synchronous generator. Then explain the transient stability limits of synchronous generator	CO 5
9	Explain the design and working of PV cell, module and array used in solar plants with neat diagram	Understand	Learner to recall the operation of PV system. Then explain the design and working of PV cell, module and array used in solar plants with neat diagram	CO 4
10	Demonstrate the equivalent circuit diagram of synchronous generator with phasor diagram	Understand	Learner to recall the operation of synchronous generator. Then explain the equivalent circuit diagram of synchronous generator	CO 5

MODULE –III

POWER CONDITIONING SCHEMES FOR SOLAR ENERGY SYSTEMS

PART - A (SHORT ANSWER QUESTIONS)

1	Demonstrate the maximum power point	Understand	Learner to recall the operation of solar power plant. Then explain the maximum power point on PV cell.	CO 6
2	List the line-commutated inverters	Remember	---	CO 7
3	Demonstrate the use of power conditioner	Understand	Learner to recall the operation of solar power plant. Then explain the use of power conditioner in solar plant.	CO 7
4	Illustrate the Grid Synchronization	Understand	Learner to recall the operation of solar power plant. Then explain the grid synchronization with solar plant	CO 7
5	Explain 3rd and 5th harmonics	Understand	Learner to recall the operation of inverters. Then explain the 3 rd and 5 th harmonics	CO 7
6	List the problems can cause harmonics	Remember	---	CO 7
7	Define harmonics	Remember	---	CO 7
8	Define power conditioner	Remember	---	CO 7
9	Define inverter used in solar power plant	Remember	---	CO 7
10	List the advantages of maximum power point tracking	Remember	---	CO 6
11	Classify the methods of synchronization	Understand	Learner to recall the operation of solar power plant. Then	CO 5

			explain the grid synchronization with solar plant	
12	Illustrate the power conditioning	Understand	Learner to recall the operation of solar power plant. Then explain the use of power conditioning in solar plant.	CO 7
13	Interpret the relation between short circuit current and irradiance on the panel surface.	Understand	Learner to recall the operation of solar power plant. Then explain the relation between short circuit current and irradiance	CO 5
14	Demonstrate the significance of optimal operating point of the PV system	Understand	Learner to recall the operation of solar power plant. Then explain the optimal operating point of PV system	CO 5
15	Find the necessity for DC-DC converter	Remember	---	CO 7
16	Classify the different converter configurations available for integration	Understand	Learner to recall the operation of solar power plant. Then explain the converter configurations for integration	CO 7
17	Define line commutated inverter	Remember	---	CO 7
18	Define power grid	Remember	---	CO 5
19	Describe AC power conditioner	Remember	---	CO 7
20	Define synchronization of solar plant	Understand	---	CO 7

PART - B (LONG ANSWER QUESTIONS)

1	Explain the solar power system with the help of block diagram and functioning units in it.	Understand	Learner to recall the operation of solar power plant. Then explain the solar power plant with block diagram	CO 5
2	Demonstrate the different power conditioning equipment used in solar power systems with neat sketch.	Understand	Learner to recall the operation of solar power plant. Then explain the power conditioning equipments used in solar plants	CO 7
3	Identify the maximum power point tracking in solar system and explain step by step with the help of an algorithm.	Apply	Learner to recall the operation of solar power plant. Then explain the maximum power point tracking in solar system	CO 6
4	Explain the single phase inverter, three phase inverter and specifications of solar inverter.	Understand	Learner to recall the operation of solar power plant. Then explain the inverters used in solar plants	CO 7
5	Demonstrate the block diagram out line about DC system in solar power system and also AC power system in solar power system.	Understand	Learner to recall the operation of solar power plant. Then explain the DC and AC power system used in solar plants	CO 7

6	Illustrate the importance of line commutated inverter in the power conditioning scheme of solar energy system.	Understand	Learner to recall the operation of solar power plant. Then explain the importance of line commutated inverter in solar power conditioning system	CO 7
7	Illustrate synchronizing harmony operation of solar generating system with the grid using block diagram.	Understand	Learner to recall the operation of solar power plant. Then explain the synchronization of grid with solar plant	CO 7
8	Explain the operation of single phase inverter	Understand	Learner to recall the operation of solar power plant. Then explain the single phase inverter used in solar plants	CO 7
9	Explain the operation of three phase inverter	Understand	Learner to recall the operation of solar power plant. Then explain the three phase inverters used in solar plants	CO 7
10	Explain the operation of DC power conditioning converters used in solar plant	Understand	Learner to recall the operation of solar power plant. Then explain the DC power conditioning converters	CO 7
11	Explain the various harmonics that generally occur in the power system	Understand	Learner to recall the operation of solar power plant. Then explain the harmonics occurs in power system	CO 7
12	Demonstrate the mitigation varieties for the trimming of harmonics and give generalized expounding.	Understand	Learner to recall the operation of solar power plant. Then explain the mitigation techniques used for reducing the harmonics	CO 7
13	Identify the solar power conditioning unit and explain the functional units present in solar power conditioning unit.	Understand	Learner to recall the operation of solar power plant. Then explain the power conditioning unit and functional units present in solar plant	CO 7
14	Explain the operating principle of incremental conductance MPPT scheme using P-V characteristics.	Apply	Learner to recall the operation of solar power plant. Then explain the maximum power point tracking scheme	CO 6
15	Classify and explain the different algorithms in MPPT tracking	Understand	Learner to recall the operation of solar power plant. Then explain the different algorithms used in MPPT	CO 6
16	Explain the parameters considered in incremental conductance for smooth drift in the output power	Understand	Learner to recall the operation of solar power plant. Then explain the parameters considered in incremental conductance	CO 6

17	Explain the importance of Fractional Open Circuit Voltage	Understand	Learner to recall the operation of solar power plant. Then explain the importance of Fractional Open Circuit Voltage	CO 6
18	Explain the operation of line commutated inverter	Understand	Learner to recall the operation of solar power plant. Then explain the operation of line commutated inverter	CO 7
19	Demonstrate the operation of solar power plant in synchronized operation with grid supply	Understand	Learner to recall the operation of solar power plant. Then explain the operation of solar power plant in synchronized operation	CO 2
20	Explain the operation of AC power conditioning converters used in solar plant	Understand	Learner to recall the operation of solar power plant. Then explain the AC power conditioning converters	CO 7
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Explain the operation of three phase inverter in 180 degree conduction mode with neat circuit diagram and waveforms	Understand	Learner to recall the operation of solar power plant. Then explain the three phase inverters used in solar plants	CO 7
2	Demonstrate the switching devices used for solar energy conversion	Understand	Learner to recall the operation of solar power plant. Then explain the switching devices used for solar energy conversion	CO 7
3	Explain the Peak power tracking photovoltaic power system along with components	Apply	Learner to recall the operation of solar power plant. Then explain the Peak power tracking photovoltaic power system along with components	CO 6
4	Explain the operation of three phase inverter in 180 degree conduction mode with neat circuit diagram and waveforms	Understand	Learner to recall the operation of solar power plant. Then explain the three phase inverters used in solar plants	CO 7
5	Demonstrate the maximum power point tracking algorithm with Perturbation and observation	Apply	Learner to recall the operation of solar power plant. Then explain the maximum power point tracking algorithm with Perturbation and observation	CO 6
6	Demonstrate the harmonic reduction methods used in solar power plants	Understand	Learner to recall the operation of solar power plant. Then explain the harmonic reduction methods used in solar power plants	CO 7
7	Explain the different types of solar energy storage with neat sketch	Understand	Learner to recall the operation of solar power plant. Then	CO 5

			explain the different types of solar energy storage with neat sketch	
8	Demonstrate the maximum power point tracking algorithm with incremental conductance	Apply	Learner to recall the operation of solar power plant. Then explain the maximum power point tracking algorithm with Perturbation and observation	CO 6
9	Explain the operation of line commutated inverter with neat circuit diagram and waveforms	Understand	Learner to recall the operation of solar power plant. Then explain the operation of line commutated inverter	CO 7
10	Explain the disadvantages of stand-alone system over grid connected system	Understand	Learner to recall the operation of solar power plant. Then explain the disadvantages of stand-alone system over grid connected system	CO 7

MODULE –IV

WIND ENERGY CONVERSION SYSTEMS

PART - A (SHORT ANSWER QUESTIONS)

1	Define wind energy conversion system	Remember	---	CO 1
2	List the applications of induction generator	Remember	---	CO 1
3	List the reasons for the application of induction generator in wind turbines.	Remember	---	CO 1
4	Find the importance of capacitor bank in self-excited induction generator.	Remember	---	CO 8
5	Define 3 rd and 5 th order harmonics	Remember	---	CO 8
6	List problems can harmonics cause	Remember	---	CO 8
7	Illustrate the harmonics present in inverters	Understand	Learner to recall the harmonics present in inverters	CO 8
8	Summarize the disadvantages of a low power factor.	Understand	Learner to recall the disadvantages of low power factor	CO 8
9	Summarize the various methods of power factor improvement.	Understand	Learner to recall the methods of power factor improvement	CO 8
10	Explain the causes of low power factor of the supply system.	Understand	Learner to recall the causes of low power factor	CO 8
11	List the advantages of induction generator	Remember	---	CO 8
12	Define self-excited induction generator	Remember	---	CO 8
13	Define AC voltage controller	Remember	---	CO 8
14	Define power factor	Remember	---	CO 8

15	List the harmonic reduction techniques	Remember	---	CO 8
16	Define isolated power generators	Remember	---	CO 8
17	Explain the importance of energy storage in wind power mills	Understand	Learner to recall the energy storage in wind power mills	CO 3
18	List the applications of wind energy conversion systems	Remember	---	CO 3
19	Define inrush current	Remember	---	CO 3
20	List the advantages of wind energy conversion systems	Remember	---	CO 3
PART - B (LONG ANSWER QUESTIONS)				
1	Explain the aim behind the using of induction generator in wind energy conversion systems.	Understand	Learner to recall the operation of wind mills. Then explain the importance of induction generator in wing energy conversion systems	CO 8
2	Explain the various applications of induction generator and also explicit the boons and banes of induction generator.	Understand	Learner to recall the operation of wind mills. Then explain the applications, advantages and disadvantages of induction generator	CO 8
3	Demonstrate the performance of self-excited generator in wind energy conversion system with the aid of technical drawing.	Understand	Learner to recall the operation of wind mills. Then explain the operation of self-excited generator in wind energy conversion system	CO 8
4	Illustrate the functioning of isolated operation of induction generators in wind energy conversion systems.	Understand	Learner to recall the operation of wind mills. Then explain the isolated operation of induction generators in WECS	CO 8
5	Explain the grid related problems in operation of wind energy conversion system and expound each of them.	Understand	Learner to recall the operation of wind mills. Then explain the grid related problems in WECS	CO 8
6	Explain ac voltage controlling in wind power systems and highlight its importance.	Understand	Learner to recall the operation of wind mills. Then explain the AC voltage controllers used in WECS	CO 8
7	Summarize the various harmonics that generally occur in the power system.	Understand	Learner to recall the operation of wind mills. Then explain the harmonics occurs in power system	CO 8
8	Summarize the mitigation varieties for the trimming of harmonics and give generalized expounding.	Understand	Learner to recall the operation of wind mills. Then explain the mitigation techniques used for reducing harmonics	CO 8
9	Demonstrate the factors that determine the output power from wind energy system	Understand	Learner to recall the operation of wind mills. Then explain the factors that determine output power from WECS	CO 3

10	Identify the causes of low power factor, its disadvantages and methods of improving the power factor.	Apply	Learner to recall the operation of wind mills. Then explain the causes of low power factor, disadvantages and methods of improving the power factor	CO 8
11	Demonstrate the grid related problems with wind energy conversion systems	Understand	Learner to recall the operation of wind mills. Then explain the grid related problems	CO 3
12	Illustrate the methods for improving the power factor	Understand	Learner to recall the operation of wind mills. Then explain the methods for improving power factor	CO 8
13	Develop the harmonic reduction techniques in WECS for reducing the harmonics	Apply	Learner to recall the operation of wind mills. Then explain the techniques used for reducing harmonics	CO 8
14	Explain the operation of AC voltage controllers with RL load	Understand	Learner to recall the operation of AC voltage controllers. Then explain the operation with RL loads	CO 8
15	Explain the generator control methods used in WECS	Understand	Learner to recall the operation of wind mills. Then explain the generator control methods used in WECS	CO 8
16	Describe the operation of wind power plant synchronization with Grid	Understand	Learner to recall the operation of wind mills. Then explain the operation of wind power plant synchronization with Grid	CO 8
17	Demonstrate wind energy conversion system with constant speed constant frequency	Understand	Learner to recall the operation of wind mills. Then explain the wind energy conversion system with constant speed constant frequency	CO 3
18	Explain variable speed constant frequency in wind energy conversion systems	Understand	Learner to recall the operation of wind mills. Then explain the wind energy conversion system with variable speed constant frequency	CO 3
19	Explain the generator control and transmission system used in wind energy conversion systems	Understand	Learner to recall the operation of wind mills. Then explain the factors that determine output power from WECS	CO 3
20	Demonstrate wind energy conversion system with variable speed variable frequency	Understand	Learner to recall the operation of wind mills. Then explain the generator control and transmission system used in wind energy conversion systems	CO 3
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Demonstrate the performance characteristics of induction generator used for wind energy	Understand	Learner to recall the operation of wind mills. Then explain the	CO 8

	conversion system		performance characteristics of induction generator used for wind energy conversion system	
2	Explain the importance of induction generator for wind energy conversion systems	Understand	Learner to recall the operation of wind mills. Then explain the importance of induction generator for wind energy conversion systems	CO 8
3	Demonstrate the grid related problems with wind power plants	Understand	Learner to recall the operation of wind mills. Then explain the grid related problems with wind power plants	CO 3
4	Explain the operating limits of grid connected systems	Understand	Learner to recall the operation of wind mills. Then explain the operating limits of grid connected systems	CO 3
5	Demonstrate the grid interface requirements for connecting a wind power plant	Understand	Learner to recall the operation of wind mills. Then explain the grid interface requirements for connecting a wind power plant	CO 3
6	Explain the load control and energy storage requirements of wind energy conversion systems	Understand	Learner to recall the operation of wind mills. Then explain the load control and energy storage requirements of wind energy conversion systems	CO 3
7	Explain the wind energy applications	Understand	Learner to recall the operation of wind mills. Then explain the wind energy applications	CO 3
8	Demonstrate the wind energy conversion system with battery storage using block diagram	Understand	Learner to recall the operation of wind mills. Then explain the wind energy conversion system with battery storage using block diagram	CO 3
9	Develop the solar wind interconnected system with battery storage using block diagram	Apply	Learner to recall the operation of wind mills. Then explain the solar wind interconnected system with battery storage using block diagram	CO 8
10	Demonstrate the wind energy conversion system with hydrogen storage using block diagram	Understand	Learner to recall the operation of wind mills. Then explain the wind energy conversion system with hydrogen storage using block diagram	CO 3

MODULE –V

POWER QUALITY ISSUES IN INTEGRATION OF RENEWABLE ENERGY RESOURCES

PART - A (SHORT ANSWER QUESTIONS)

1	Define stand-alone system.	Remember	---	CO 9
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2	List various stand-alone systems.	Remember	---	CO 9
3	List different renewable stand-alone systems.	Remember	---	CO 9
4	Define grid connected system.	Remember	---	CO 9
5	Classify the grid connected systems.	Understand	Learner to recall the classification of grid connected systems	CO 9
6	Illustrate the difference between stand alone and grid connected systems.	Understand	Learner to recall the difference between stand alone and grid connected systems	CO 9
7	Name the power quality measuring equipment.	Remember	---	CO 9
8	Define Point harmonic analyzer.	Remember	---	CO 9
9	Define power quality.	Remember	---	CO 9
10	Demonstrate distribution generation.	Understand	Learner to recall the operation of distribution generation	CO 9
11	Define grid connected system	Remember	---	CO 9
12	List various grid connected systems	Remember	---	CO 9
13	List the power quality issues	Remember	---	CO 9
14	Define distribution generation	Remember	---	CO 9
15	Define custom power device	Remember	---	CO 10
16	List the mitigation techniques of power quality issues	Remember	---	CO 10
17	Define voltage sag or dip	Remember	---	CO 10
18	List the applications of custom power devices	Remember	---	CO 10
19	Define load compensation	Remember	---	CO 10
20	Define voltage swell	Remember	---	CO 10
PART - B (LONG ANSWER QUESTIONS)				
1	Explain a solar stand-alone system and discuss about various units present in the solar stand-alone system.	Understand	Learner to recall the operation of solar stand-alone system. Then explain the various units present in solar stand-alone system	CO 9
2	Explain a wind stand-alone system and discuss about various units present in the wind stand-alone system,	Understand	Learner to recall the operation of wind stand-alone system. Then explain the various units present in wind stand-alone system	CO 9
3	Demonstrate the power quality issues in the integration of renewable energy resources and reasons for those issues.	Understand	Learner to recall the power quality issues with integration of grid. Then explain the reasons for those issues	CO 9

4	Illustrate various power quality problems which generally occur in the integration of renewable resources and discuss the steps we have to take to control them.	Understand	Learner to recall the power quality problems. Then explain the steps to control them	CO 9
5	Explain the grid connected renewable energy resource and discuss about the different functional units present in it.	Understand	Learner to recall the renewable energy resource. Then explain the grid connected renewable energy resource	CO 9
6	Demonstrate the distributed generation and recognize the impact of power quality problems on distribution generation.	Understand	Learner to recall the operation of distributed generation. Then explain the power quality problems on distribution generation	CO 9
7	Develop various mitigation techniques used for the commanding of power quality in distribution generation.	Apply	Learner to recall the operation of distributed generation. Then explain the various mitigation techniques used for power quality improvement	CO 9
8	Demonstrate the custom power devices used in distributed generation and discuss about their functioning.	Understand	Learner to recall the operation of distributed generation. Then explain the custom power devices used in DG	CO 10
9	Demonstrate the operation of DVR(Dynamic Voltage Restorer)	Understand	Learner to recall the operation of Dynamic Voltage Restorer	CO 10
10	Demonstrate the operation of UPQC(Unified Power Quality Conditioner)	Understand	Learner to recall the operation of Unified Power Quality Conditioner	CO 10
11	Explain a solar grid connected system and discuss about various units present in the solar grid connected system.	Understand	Learner to recall the operation of solar grid connected system. Then explain the various units present in solar grid connected system	CO 9
12	Explain a wind grid connected system and discuss about various units present in the wind grid connected system.	Understand	Learner to recall the operation of wind grid connected system. Then explain the various units present in wind grid connected system	CO 9
13	Demonstrate the custom power devices used in distributed generation	Understand	Learner to recall the operation of distributed generation. Then explain the custom power devices used in DG	CO 10
14	Demonstrate the operation of DSTATCOM (Distribution Static Synchronous Compensator).	Understand	Learner to recall the operation of Static Synchronous compensator	CO 10
15	Demonstrate the operation of Static VAR Compensator (SVR) and APF(Active Power Filters).	Understand	Learner to recall the operation of Static Var Compensator and Active Power Filters.	CO 10
16	Demonstrate Impacts of Power Quality Problems on End Users	Understand	Learner to recall the Impacts of Power Quality Problems on End Users	CO 10

17	Explain the Power Quality Monitoring	Understand	Learner to recall the Power Quality. Then explain the power quality monitoring	CO 9
18	Demonstrate the analysis of voltage sag	Understand	Learner to recall the Power Quality. Then explain the analysis of voltage sag	CO 9
19	Explain the load compensation using DSTATCOM	Understand	Learner to recall the Power Quality. Then explain the load compensation using DSTATCOM	CO 10
20	Demonstrate the Utility-Customer Interface	Understand	Learner to recall the Power Quality. Then explain the Utility-Customer Interface	CO 9
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)				
1	Demonstrate the grid interface requirements of renewable energy integration	Understand	Learner to recall the operation renewable energy sources. Then explain the grid interface requirements of renewable energy integration	CO 9
2	Explain the solar wind interconnected system with battery storage using block diagram	Understand	Learner to recall the operation of solar and wind mills. Then explain the solar wind interconnected system with battery storage using block diagram	CO 9
3	Demonstrate the advantages of grid connected systems over stand alone systems	Understand	Learner to recall and explain the advantages of grid connected systems over stand alone systems	CO 9
4	Explain the synchronization of renewable energy sources with grid	Understand	Learner to recall and explain the synchronization of renewable energy sources with grid	CO 9
5	Demonstrate the inrush current and synchronized operation of renewable energy sources	Understand	Learner to recall and explain the inrush current and synchronized operation of renewable energy sources	CO 9
6	Explain the operation of DC Storage Unit used in dynamic voltage restorer	Understand	Learner to recall and explain the operation of DC Storage Unit used in dynamic voltage restorer	CO 9
7	Demonstrate the characteristics of Voltage Sag	Understand	Learner to recall and explain the characteristics of Voltage Sag	CO 10
8	Explain the causes of transients in grid connected systems	Understand	Learner to recall and explain the causes of transients in grid connected systems	CO 9
9	Demonstrate the voltage sag and voltage swell during transients in grid connected systems	Understand	Learner to recall and explain the voltage sag and voltage	CO 10

			swell during transients in grid connected systems	
10	Demonstrate the short interruptions and long interruptions occurs in grid connected systems	Understand	Learner to recall and explain the short interruptions and long interruptions occurs in grid connected systems	CO 9

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