INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	**WIND AND SOLAR ENERGY SYSTEMS**
Course Code	:	**AEEB46**
Program	:	**B. Tech**
Semester	:	**V**
Branch	:	**Electrical and Electronics Engineering**
Section	:	**A&B**
Academic Year	:	**2020 – 2021**
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 equipment 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 the course students will be able to	
CO No	**COURSE OUTCOMES**
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.

DEFINITIONS AND TERMINOLOGYQUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CO
UNIT - I DESIGN AND OPERATION OF WIND POWER SYSTEM				
1	Describe the blade velocity of wind turbine	Wind turbine experiences change in velocity dependent upon the blade inlet angle and the blade velocity Since the blades are long, the blade velocity varies with the radius to a greater degree than steam or gas-turbine blades and the blades are therefore twisted.	Remember	CO 1
2	Describe Halladay wind mill	Invented by Daniel Halladay in 1854, the Halladay Standard was the first commercially successful self-governing windmill in 1854 was the firms of Halladay, McCray & Co., Ellington, Conn. Partners in the company were inventor Daniel Halladay, John Burnham and Henry McCray.	Remember	CO 1
3	Describe the efficiency of the turbine	As wind turbine wheel cannot be completely closed, and because of spillage and other effects, practical turbines have 50 to 70% of the ideal efficiency. The real efficiency η is the product of this and ηmax and is the ratio of an actual to total power. P = ηPtot.	Remember	CO 2
4	Classify the propeller type wind mill	There are two types of forces operating on the blades of a propeller type wind turbine. They are the circumferential forces in the direction of wheel rotation that provide the torque and the axial forces in the direction of the wind stream that provide an axial thrust that must be counteracted by proper mechanical design.	Remember	CO 2
5	Define nacelle	The nacelle is the part of the turbine that houses the components that transform the wind's kinetic energy into mechanical energy to turn a generator that produces electricity	Remember	CO 3
6	Define yaw control	The Wind Turbine Yaw Mechanism. The wind turbine yaw mechanism is used to turn the wind turbine rotor against the wind. The wind turbine is said to have a yaw error, if the rotor is not perpendicular to the wind. A yaw error implies that a lower share of the energy in the wind will be running through the rotor area.	Remember	CO 3
7	Describe rotor swept area	The larger the diameter of its blades, the more power it is capable of extracting from the wind. Rotor Diameter This number is listed on most wind turbine spec sheets. It is simply the diameter the blades cover. Swept area This refers to the area in square feet of the rotor	Remember	CO 2

S.No	QUESTION	ANSWER	Blooms Level	CO
8	Define air density	Clearly the most important variable is wind speed. The area swept out by of the turbine is a constant and the density of air is generally taken as 1.225 kg/m^3, its value at sea level at 15 degrees C	Remember	CO 1
9	Describe the windmill blades made with sheet metal or aluminum	Horizontal axis multi blade windmill is made from sheet metal or aluminum. The rotors have high strength to weight ratios. They have good power coefficient, high starting torque and added advantages of simplicity and low cost.	Remember	CO 2
10	Describe the wind mill bladesmade with cloth	The blade surface of sail type wind mill is made of cloth, nylon or plastics arranged as mast and pole or sail wings. There is also variation in the number of sails used. Sails are found in different designs, from primitive common sails to the advances patent sails.	Remember	CO 3
11	Describe the windmill which gives better performance	The horizontal axis mills generally have netter performance. They have been used for various applications including electric power generation, and pumping water. The latter introduces some complexity into the design as the mechanical energy has to be transmitted over a distance.	Remember	CO 2
12	Define tip speed ratio	The tip speed ratio, X, or TSR for wind turbines is the ratio between the tangential speed of the tip of a blade and the actual speed of the wind. The tip speed ratio is related to efficiency, with the optimum varying with blade design.	Understand	CO 2
13	Describe the number of propellers used in windmills	Wind turbines have been built with up to six propellers type blades but two and three bladed propellers are most common. A one bladed rotor with a balancing counter weight has some advantages, including lower weight and cost and simpler controls, over the multi-bladed type.	Remember	CO 2
14	Turbines with how many propellers are used in order to avoid vibrations?	Turbines with three blades are used to avoid vibrations that occur due to the turning or yawing of the rotor in order to face in into the wind. However, this problem can be overcome by controlling the yaw rate.	Remember	CO 2
15	Describe the drawbacks of windmill	Wind turbine blades do indeed kill birds and bats, but their contribution to total bird deaths is extremely low, as these three studies show.	Remember	CO 2
UNIT – II DESIGN AND OPERATION OF PV SYSTEM				
1	Describe the Residential Solar Electric System	Solar cells in the modules mounted on your roof convert sunlight directly into DC power. A component called an inverter converts this DC power into AC power that can be used in your home. The system is interconnected with your utility. During the day, if your solar system produces more electricity than your home is using, your utility may allow net metering or the crediting of your utility account for the excess power generated being returned to the grid. Your utility would provide power as usual at night and during the day when your electricity demand exceeds that produced by your solar system. Systems are also available with a battery backup. Part of the power produced by your solar system during the day is used to charge the batteries, which provide power for your critical loads in the event of a power outage.	Remember	CO 6
2	Define photovoltaic	Photovoltaics (PV) is the conversion of light into electricity using semiconducting materials that exhibit	Understand	CO 6

S.No	QUESTION	ANSWER	Blooms Level	CO
		the photovoltaiceffect, a phenomenon studied in physics, photochemistry, and electrochemistry.		
3	Describe the solar system on Cloudy Days	Yes, though they produce less electricity. Under a light overcast sky, panels might produce about half as much as under full sun	Remember	CO 6
4	Describe the rate of solar energy received by the earth	The solar energy reaching the surface of the earth is about 1016W whereas the worldwide power demand is 1013W. That means solar energy gives us 1000 times more energy than our requirement.	Remember	CO 7
5	Describe the solar energy received by earth and atmosphere	Even if we use 5% of this energy, it is more than 50 times our requirement. The total solar radiation absorbed by the earth and its atmosphere is 3.8 X 1024 Joules/year. Except that it is distributed over the area of earth.	Remember	CO 7
6	Describe the common source of energy from which electricity is produced	Coal is the most common source of energy that is being used since industrialization. Modern steam boilers can burn coal in any of its form as a primary fuel. Different ranks of coal available are peat, lignite, bituminous and anthracite.	Remember	CO 7
7	Describe peak power point operation	The voltage at which PV module can produce maximum power is called maximum power point (or peak power voltage). Maximum power varies with solar radiation, ambient temperature and solar cell temperature.	Understand	CO 7
8	Define transient stability	Transient stability is generally referred to as the ability of. The system to regain synchronism after major disturbances like. Loss of generator, line switching, large load changes or faults.	Remember	CO 6
9	Describe the solar energy radiation	Solar energy is radiated from the sun in the form of electromagnetic waves of shorter wavelength of 0.2 to 0.4 micrometers. Out of all the solar energy radiations reaching the earth's atmosphere, 8% is ultraviolet radiation, 40% is visible range light and 46% is by infrared radiation.	Remember	CO 6
10	Describe MHD	Magneto hydro dynamic is a generator which is used for direct conversion of thermal energy into electrical energy. They work on faraday principle. When an electric conductor moves across a magnetic field, electric current is produced.	Understand	CO 6
11	Define direct radiation	Solar radiation that has not been absorbed or scattered and reaches the ground from the sun is called direct radiation or beam radiation. It is the radiation which produces a shadow when interrupted by an opaque object.	Understand	CO 7
12	Define Diffuse radiation	Diffuse radiation received from the sun after its direction has been changed by reflection and scattering by the atmosphere. Since the solar radiation is scattered in all direction in the atmosphere, diffuse radiation comes to the earth from all parts of the sky.	Remember	CO 6
13	Define Insolation	Insolation is the total solar radiation received at any point on any point on the earth's surface. In other words insolation is the sum of the direct and diffuse radiation. More specifically insolation is defined as the total solar radiation energy received on a horizontal surface of unit area on the ground in unit time.	Understand	CO 6
14	Describe the Insolation	The insolation at a given point or location on the earth's surface depends among other factors, on the altitude of the sun in the sky. As a result of absorption	Understand	CO 6

S.No	QUESTION	ANSWER	Blooms Level	CO
		and scattering, the insolation is less when the sun is low in the sky than when it is higher.		
15	Describe the drawbacks of solar panels	Yes, birds have died at solar photovoltaic projects, some of them from crashing into panels or other infrastructure.	Understand	CO 7
MODULE-III POWER CONDITIONING SCHEMES FOR SOLAR ENERGY SYSTEMS				
1	Define grid connected solar PV	A grid-connected photovoltaic system, or grid-connected PV system is an electricity generating solar PV power system that is connected to the utility grid.	Remember	CO 7
2	Describe the classification of grid connected solar PV	On-grid, grid-connected or grid-tied means connected to the utility electrical grid. Our solar electric systems are designed as on-grid systems, meaning that they interconnect with your existing utility service. Off-grid refers to systems that are not connected to the utility electrical grid. Our solar electric packaged systems are not designed for off-grid applications. An off-grid system must be custom designed by a solar power expert.	Remember	CO 7
3	Define inverters	Inverters are used to convert DC power into variable AC power. The variable AC power means variable frequency and variable voltage level.	Remember	CO 7
4	Describe the short circuit problem involtage source inverter.	Yes, Short-circuit problem is severe in case of voltage source inverter. The output voltage of VSI is fixed but the output current depends upon the load. When Z=0, I=V÷Z=∞.	Remember	CO 8
5	Describe the switches used in CSI	Switches used in CSI are bipolar and unidirectional in nature. GTO, thyristors are the examples of switches used in CSI. The output voltage of CSI is variable but the output current is fixed.	Remember	CO 8
6	Describe VSI	VSI stands for Voltage source inverter. The output voltage of VSI is fixed but the output current depends upon the load. Switches used in VSI are unipolar and bidirectional in nature.	Remember	CO 8
7	Define CSI	CSI stands for Current source inverter. The output voltage of CSI is variable but the output current is fixed.	Remember	CO 8
8	Describe the no of switches in conduction for 180^0 conduction mode in 3 phase VSI	In 3-phase 180° VSI each phase conducts for 180° and only two switches from different phases conduct at a single time.	Understand	CO 7
9	Describe the no of switches in conduction for 120^0 conduction mode in 3 phase VSI	In 3-phase 120° VSI each phase conducts for 120° and only three switches from different phases conduct at a single time.	Remember	CO 8
10	Define line commutation	Natural or Line commutation is a Class-F SCR commutation technique in which, a thyristor is turned off due to natural current zero and voltage reversal after every half cycle	Remember	CO 8
11	Define synchronized operation	In an alternating current electric power system, synchronization is the process of matching the speed and frequency of a generator or other source to a running network. ... If two segments of a grid are disconnected, they cannot exchange AC power again until they are brought back into exact synchronization.	Understand	CO 7

S.No	QUESTION	ANSWER	Blooms Level	CO
12	Define MPPT	Maximum power point tracking (MPPT) or sometimes just power point tracking (PPT)) is a technique used commonly with wind turbines and photovoltaic (PV) solar systems to maximize power extraction under all conditions.	Understand	CO 7
13	Define solar energy	Solar energy is simply the light and heat that come from the sun. People can harness the sun's energy in a few different ways: Photovoltaic cells, which convert sunlight into electricity. Passive solar heating, which can be as simple as letting the sun shine through windows to heat the inside of a building.	Remember	CO 7
14	Describe the importance of solar energy	No greenhouse gas emissions are released into the atmosphere when you use solar panels to create electricity. And because the sun provides more energy than we'll ever need, electricity from solar power is a very important energy source in the move to clean energy production.	Understand	CO 7
15	Define PV cell	A photovoltaic (PV) cell, also known as a solar cell, is an electronic component that generates electricity when exposed to photons, or particles of light. This conversion is called the photovoltaic effect	Understand	CO 7
UNIT – IV WIND ENERGY CONVERSION SYSTEMS				
1	Classify the induction motors used in wind mills	i. Squirrel cage induction motor ii. Slip ring induction motor	Remember	CO 4
2	Describe the skewing in induction motors	To make the motor run quietly by reducing the magnetic hum ii. to reduce the locking tendency of the rotor	Remember	CO 4
3	Define asynchronous motor	Since the induction motor runs always at a speed lesser than synchronous speed, it is called asynchronous motor.	Remember	CO 5
4	What is self excited induction generator?	Self-excited DC Generator is a device, in which the current to the field winding is supplied by the generator itself.	Remember	CO 5
5	Describe the voltage build up in an isolated induction generator	Voltage build up will depend on capacitance and the residual magnetism of the rotor iron.	Remember	CO 4
6	Describe the application of induction generators	Induction generator is widely acceptable in low speed and low power operation like wind power systems.	Remember	CO 4
7	Which type of windmill has better performance?	The horizontal axis mills generally have better performance.	Remember	CO 4
8	Describe the power generated by small scale wind machine	These might be used on farms remote applications and other places requiring relatively low power. The generating capacity is up to 2kW. Small scale wind machines lower your electricity bills by 50% – 90%.	Remember	CO 4
9	Describe the factors effecting the power output of a wind turbine	The three main factors that influence power output are: wind speed, air density, and blade radius. Wind turbines need to be in areas with a lot of wind on a regular basis, which is more important than having occasional high winds.	Remember	CO 5

S.No	QUESTION	ANSWER	Blooms Level	CO
10	Do wind turbines produce AC or DC	The generator in a wind turbine produces alternating current (AC) electricity. Some turbines drive an AC/AC converterwhich converts the AC to direct current (DC) with a rectifier and then back to AC with an inverterin order to match the frequency and phase of the grid.This leads to a more stable power system.	Understand	CO 5
11	Describe the voltage levels of wind turbine	A modern wind turbine is often equipped with a transformer stepping up the generator terminal voltage, usually a voltage below 1 kV (E.g. 575 or 690 V), to a medium voltage around 20-30 kV.	Remember	CO 5
12	Define AC voltage controller	Voltage controllers convert the fixed ac voltage to variable ac by changing the values of the firing angle.	Understand	CO 5
13	Describe the technique is used in harmonic reduction in inverters	Two or more inverters are connected together by means of a transformer to get the net output voltage with reduced harmonic content.	Remember	CO 5
14	Describe the advantages of the static capacitors	Low losses, Easy installation and Lower maintenance	Understand	CO 4
15	Define phase advancer	Phase advancer is a source of reactive power, connected either to certain junction points in an electrical network or directly to the load terminals; it is used to compensate the phase shift between voltage and current.	Remember	CO 4
UNIT – V POWER QUALITY ISSUES IN INTEGRATION OF RENEWABLE ENERGY RESOURCES				
1	Define power quality	Power quality is commonly defined as the power grid's ability to supply a clean and stable power flow as a constantly available power supply. The power flow should have a pure sinusoidal wave form and it should remain within specified voltage and frequency tolerances.	Remember	CO 9
2	Define stand alone system	A stand-alone power system (SAPS or SPS), also known as remote area power supply (RAPS), is an off-the-grid electricity system for locations that are not fitted with an electricity distribution system. Typical SAPS include one or more methods of electricity generation, energy storage, and regulation.	Remember	CO 9
3	Define grid connected system	A grid-connected system allows you to power your home or small business with renewable energy during those periods (daily as well as seasonally) when the sun is shining, the water is running, or the wind is blowing. Any excess electricity you produce is fed back into the grid. When renewable resources are unavailable, electricity from the grid supplies your needs, eliminating the expense of electricity storage devices like batteries.	Understand	CO 9
4	Describe distributed generation	Distributed generation, also distributed energy, on-site generation (OSG),[1] or district/decentralized energy, is electrical generation and storage performed by a variety of small, grid-connected or distribution system-connected devices referred to as distributed energy resources	Remember	CO 9

S.No	QUESTION	ANSWER	Blooms Level	CO
5	Describe the power quality issues	Power quality problems are: Automatic Resets, Data Errors, Equipment Failure, Circuit Board Failure, Memory, Loss, Power Supply Problems, UPS Alarms, Software Corruption, and Overheating of electrical distribution systems.	Remember	CO 9
6	Define voltage sag	A voltage sag (or dip) is a disturbance where the rms value of the line voltage is reduced for a period ranging from one half-cycle of the voltage to 500 ms. Shorter occurrences are regarded as transient disturbances. Occurrences during longer than 500 ms are defined as an under voltage condition	Remember	CO 9
7	Define voltage swell	Voltage swells are brief increases in voltage over the same time range. Voltage sags are the most common power disturbance.	Remember	CO 9
8	Define harmonics	Harmonics is the generalized term used to describe the distortion of a sinusoidal waveform by waveforms of different frequencies. Then whatever its shape, a complex waveform can be split up mathematically into its individual components called the fundamental frequency and a number of harmonic frequencies.	Remember	CO 9
9	Describe the causes of harmonics	Nonlinear loads are the primary causes of harmonics in an electrical system. Non-linear loads draw short bursts of current, which creates a situation where current is not proportional to the voltage. These loads create harmonic distortion that can have adverse effects on your equipment.	Remember	CO 9
10	Describe custom power	Custom power is a strategy, which is intended principally to convene the requirement of industrial and commercial consumers. The concept of the custom power is tools of application of power electronics controller devices into power distribution system to supply a quality of power, demanded by the sensitive users	Remember	CO 10
11	Describe the mitigation of power quality	Power quality consists of a large number of disturbances such as voltage sags, swells, harmonics, notch, flicker, etc. Power quality problems can be mitigated by many methods but most appropriate solution to mitigate these problems are FACTS devices.	Remember	CO 10
12	Describe the voltage imbalance	Voltage imbalance is the measure of voltage differences between the phases of a three-phase system. It degrades the performance and shortens the life of three-phase motors. The impact of the transients on motors can be severe.	Remember	CO 9
13	Describe the causes of voltage sag	Voltage sags are caused by abrupt increases in loads such as short circuits or faults, motors starting, or electric heaters turning on, or they are caused by abrupt increases in source impedance, typically caused by a loose connection.	Remember	CO 10
14	Describe the causes of voltage swell	Voltage swells are almost always caused by an abrupt reduction in load on a circuit with a poor or damaged voltage regulator, although they can also be caused by a damaged or loose neutral connection. Voltage sags are the most common power disturbance.	Understand	CO 10

S.No	QUESTION	ANSWER	Blooms Level	CO
15	Describe custom power devices	The concept of the custom power is tools of application of power electronics controller devices into power distribution system to supply a quality of power, demanded by the sensitive users.	Understand	CO 9

Signature of the Faculty **HOD, EEE**