

INSTITUTE OF AERONAUTICAL ENGINEE, RING

(Autonomous) Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

DEFINITIONS AND TERMINOLOGY QUESTION BANK

Course Name	:	SOLAR ENERGY SYSTEMS
Course Code	:	AME532
Program	:	B.Tech
Semester	:	VI
Branch	:	Mechanical Engineering
Section	:	Α
Academic Year	:	2018–2019
Course Faculty	:	Mr. M. Sunil Kumar, Assistant Professor, ME

OBJECTIVES:

Ι	To help students to consider in depth the terminology and nomenclature used in the syllabus.
II	To focus on the meaning of new words / terminology/nomenclature

DEFINITIONS AND TERMINOLOGY QUESTION BANK

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code			
	UNIT-I INTRODUCTION TO SOLAR ENERGY							
1	What is solar Energy	The process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect. Currently solar panels convert most of the visible light spectrum and about half of the ultraviolet and infrared light spectrum to usable solar energy.	Remember	CLO1	CAME525.01			
2	Explain the history of solar energy utilization	In the year 1954 first photo voltaic cell is invented. Solar energy is first used in space to power satellities.	Understand	CL01	CAME525.01			
3	What is black body radiation.	An object that absorbs all radiation falling on it, at all wavelengths, is called a black body. When a black body is at a uniform temperature, its emission has a characteristic frequency distribution that depends on the temperature. Its emission is called black-body radiation.	Understand	CL02	CAME525.02			
4	State wein displacement law.	Wien's displacement law states that the black body radiation curve for different temperature peaks at a wavelength is inversely proportional to the temperature. b is a constant of	Understand	CLO1	CAME525.01			

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
5	Explain the photoelectric effect	proportionality called Wien's displacement constant, equal to2.8977729(17)×10–3 m·K, or to obtain wavelength in micrometers, $b \approx 2900 \ \mu m$. The photoelectric efect is the emission of electrons or other free carriers when light shines on a material. Electrons emitted in this manner can be called photo electrons	Remember	CL01	CAME525.01
6	Explain Stefan Boltzmann's law	This law states that the energy radiated from a black body is proportional to the fourth power of the absolute temperature. A black body is one which absorbs and emits radiation at all frequencies, with characteristic continuous emission spectra. σ -Stefan-Boltzmann constant [Value: 5.67 x 10-8 J s-1 m-2 K-4]	Understand	CL01	CAME525.01
7	Explain Plank's constant.	Max Planck theorized that energy was transferred in chunks known as quanta, equal to h . The variable h is a constant equal to 6.63×10^{-34} J·s and the variable represents the frequency in 1/s. This equation allows us to calculate the energy of photons, given their frequency. If the wavelength is given, the energy can be determined by first using the wave equation to find the frequency, then using Planck's equation to calculate energy.	Understand	CL01	CAME525.01
8	State Wein displacement law.	Wien's displacement law states that the black body radiation curve for different temperature peaks at a wavelength is inversely proportional to the temperature. The spectrum of black body radiation toward shorter wavelengths as temperature increases.	Understand	CLO2	CAME525.02
9	Explain the equation of Stefan-Boltzman's	According to Stefan's Boltzmann law (formulated by the Austrian physicists, Stefan and Boltzmann), energy radiated per unit area per unit time by a body is given by, $R = \epsilon \sigma T^4$ (1) Where R = energy radiated per area per time, $\varepsilon =$ emissivity of the material of the body, $\sigma =$ Stefan's constant = 5.67x10 ⁻⁸ Wm ⁻² K ⁻⁴ , and T is the temperature in Kelvin scale.	Remember	CLO2	CAME525.02
10	Explain Einstein's theory of photon's	Einstein created the quantum theory of light, the idea that light exists as tiny packets, or particles, which he	Understand	CLO3	CAME525.03

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
		called photons. $E=mc^2$			
11	Explain history of solar energy utilization.	The history of solar energy is as old as humankind. In the last two centuries, we started using Sun's energy directly to make electricity. In 1839, Alexandre Edmond Becquerel (pictured on the right) discovered that certain materials produced small amounts of electric current when exposed to light.	Understand	CLO2	CAME525.02
12	Define spectrum of radiation of sun	 Radio Waves. Radio waves have the longest wavelengths of all the electromagnetic waves. Microwaves. Microwaves are shorter than radio waves with wavelengths measured in centimeters. Infrared. Between microwaves and visible light are infrared waves. Visible light. Ultraviolet. X-rays. Gamma ray. 	Remember	CL01	CAME525.01
13	What is electromagnetic spectrum.	The electromagnetic spectrum covers electromagnetic waves with frequencies ranging from below one hertz to above 10^{25} hertz,	Understand	CLO1	CAME525.01
14	Explain Planck's formula in wavelength	Planck's law for the energy E_{λ} radiated per unit volume by a cavity of a blackbody in the wavelength interval λ to $\lambda + \Delta\lambda$ ($\Delta\lambda$ denotes an increment of wavelength) can be written in terms of Planck's constant (h), the speed of light (c), the Boltzmann constant (k), and the absolute temperature (T)	Understand	CLO2	CAME525.02
15	Define black body radiation	Black-body radiation is the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment, or emitted by a black body (an opaque and non-reflective body). It has a specific spectrum and intensity that depends only on the body's temperature	Understand	CL01	CAME525.01

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
		UNIT-II			
	ORIGIN OF SOLAR	ENERGY, TRACKING OF SUNLIGHT	Γ AND AT	MOSF	PHERIC
		INTERACTION	r		
1	Explain the basic parameters of the sun.	Characteristics of the Sun. The Sun is the largest object in the Solar System, accounting for 99.86% of the mass. As stars go, the Sun is actually a medium- sized, and even smallish star. Stars with much more mass can be much larger than the Sun.	Understand	CLO5	CAME525.05
2	Explain the solar constant.	The solar constant (G_{SC}) is a flux density measuring mean solar electromagnetic radiation (solar irradiance) per unit area. It is measured on a surface perpendicular to the rays, one astronomical unit (AU) from the Sun (roughly the distance from the Sun to the Earth).	Understand	CLO3	CAME525.03
3	What is meant by Solar Energy	The energy received in the form of radiation, can be converted directly or indirectly into other forms of energy, such as heat and electricity, which can be utilized by man.	Remember	CLO3	CAME525.03
4	Define solar constant	Solar constant is defined as the amount of energy received in unit time on a unit area perpendicular to the sun's direction at the mean distance of the earth from the sun.	Remember	CLO3	CAME525.03
5	Define solar time.	Solar time (Local Apparent Time) is measured with reference to solar noon, which is the time when the sun is crossing the observer's meridian.	Understand	CLO4	CAME525.04
6	Explain Rayleigh scattering.	Rayleigh scattering, dispersion of electromagnetic radiation by particles that have a radius less than approximately 1/10 the wavelength of the radiation.	Understand	CLO3	CAME525.03
7	Summarize about direct sunlight.	Direct sunlight is sunlight that shines onto a plant at full strength, with nothing getting between the sunlight and the plant.	Remember	CLO4	CAME525.04
8	Explain scattered sunlight	Sunlight is very intense and when it shines through the whole atmosphere, where there's lots of air, we are able to see the scattered sunlight. The atmosphere also contains particulates and clouds and they scatter sunlight.	Understand	CLO3	CAME525.03

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
9	Explain about universal standard time.	Universal Time (UT) is a time standard based on Earth's rotation. It is a modern continuation of Greenwich Mean Time (GMT), i.e., the mean solar time onthe Prime Meridian at Greenwich, England.	Understand	CLO4	CAME525.04
10	How to calculate local time.	The local standard time meridian, measured in degrees, which runs through the center of each time zone. It can be calculated by multiplying the differences in hours from Greenwich Mean Time by 15 degrees per hour.	Remember	CLO3	CAME525.03
11	Explain solar time.	It is the difference between mean solar time (as shown by clocks) and apparent solar time (indicated by sundials), which varies with the time of year.	Understand	CLO4	CAME525.04
12	Define equation of time	The Equation of Time. The Equation of Time is a way of quantifying the variable part of the difference between time kept by an ordinary electrical or mechanical clock, keeping civil time, and the time kept by the Sun,	Understand	CLO3	CAME525.03
13	How intensity is measured	At Earth's distance from the sun, an average of about 1370 W/m^2 of power reaches the top of the Earth/atmosphere system. The amount of sunlight reaching a horizontal surface at Earth's surface is called insolation, measured in units of watts per square meter (W/m^2).	Understand	CLO4	CAME525.04
14	Define absorption of the molecules,	Radiation is more likely to be absorbed at frequencies that match the energy difference between two quantum mechanical states of the molecules. The absorption that occurs due to a transition between two states is referred to as an absorption line and a spectrum is typically composed of many lines.	Remember	CLO3	CAME525.03
15	Explain the structure of the Sun	The sun has six layers. Three layers, the corona, chromosphere, and photosphere, comprise the sun's atmosphere or outer layer. The other three layers, convective zone, radiative zone, and core, comprise theinner layers, or the parts of the sun that are not seen	Understand	CLO3	CAME525.03

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
	UNII	-III SOLAR CELLS, PHOTOVOLATI	C BASICS		
1	Give the applications of solar PV system?	Water Pumping, Battery Charging, Grid-Interactive PV Power Generation, Lightning, Medical Refrigeration, Village Power, Telecommunication and Signaling	Understand	CLO4	CAME525.04
2	What is PN junction.	Formation of a P-n junction. P-n junctions are formed by joining n-type and p-type	Remember	CLO12	CAME525.12
3	How is a pn junction diode made?	The p-n junction, which is formed when the p-type and n-type semiconductors are joined, is called as p-n junction diode. The p-n junction diode is made from the semiconductor materials such as silicon, germanium, and gallium arsenide. For designing the diodes, silicon is more preferred over germanium.	Understand	CLO12	CAME525.12
4	What PN Junction theory	By adding connections to each end of the P-type and the N-type materials we can produce a two terminal device called a PN Junction Diode which can be biased by an external voltage to either block or allow the flow of current through it. Semiconductor Basics. PN Junction Diode	Understand	CLO12	CAME525.12
5	What are semiconductor material	A solid substance that has a conductivity between that of an insulator and that of most metals, either due to the addition of an impurity or because of temperature effects. Devices made of semiconductors, notably silicon, are essential components of most electronic circuits	Understand	CLO12	CAME525.12
6	Why do we use diode	Main functions. The most common function of a diode is to allow an electric current to pass in one direction (called the diode's forward direction), while blocking it in the opposite direction (the reverse direction). As such, the diode can be viewed as an electronic version of a check valve.	Remember	CLO12	CAME525.12
7	Explain about quasi fermi level	A quasi Fermi level is a term used in quantum mechanics and especially in solid state physics for the Fermi level (chemical potential of electrons) that describes the population of electrons separately in the conduction band and valence band.	Understand	CLO13	CAME525.04
8	equation.	line Shockley diode equation or the diode law, named after transistor co-invenOR	Remember	CLO12	CAME525.12

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
		willam shocley of Bell Telephone Laboratories, gives the I–V (current- voltage) characteristic of an idealized diode in either forward or reverse bias			
9	What is Thin film solar cells	A thin-film solar cell is a second generation solar cell that is made by depositing one or more thinlayers, or thinfilm (TF) of photovoltaic material on a substrate, such as glass, plastic or metal.	Understand	CLO12	CAME525.12
10	What is CIGS	Copper indium gallium selenide solar cell is a thin-film solar cell.	Remember	CLO12	CAME525.12
11	Explain tandem solar cells	Tandem solar cells made of silicon and metal halide perovskite compounds can convert a particularly large portion of the solar spectrum into electrical energy	Understand	CLO13	CAME525.13
12	Define organic cell	An organic solar cell or plastic solar cell is a type of photovoltaic that uses organic electronics, a branch of electronics that deals with conductive organic polymers or small organic molecules, for light absorption and charge transport to produce electricity from sunlight by the photovoltaic effect	Understand	CLO12	CAME525.12
13	Explain about dye- sensitized solar cell.	A dye-sensitized solar cell is a low- cost solar cell belonging to the group of thin film solar cells. It is based on a semiconductor formed between a photo- sensitized anode and an electrolyte, a photo electrochemical system.	Understand	CLO13	CAME525.13
14	What are Materials used for organic solar cells	Lead(II) Bromide, Lead(II) Chloride, Cesium Lead Triiodide, Rubrene (purified by sublimation)	Understand	CLO11	CAME525.11
15	Explain behavior of Solar cells	A silicon solar cell is a diode formed by joining p-type (typically boron doped) and n- type (typically phosphorous doped) silicon. Light shining on such a cell can behave in a number of ways	Remember	CLO11	CAME525.11

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
		UNIT-IV			
		SOLAR ENERGY			
1	What is meant by solar collector? Mention its types.	A solar collector is a device for collecting solar radiation and transfers the energy to a fluid passing in contact with it. There are two types of collectors: Non- concentrating or flat plate type solar collector. Concentrating (focusing) type solar collector.	Remember	CLO7	CAME525.07
2	Mention the ways of solar energy can be utilized	Solar energy can be utilized directly in two ways: By collecting the radiant heat and using it in a thermal system By collecting and converting it directly to electrical energy using a photovoltaic system	Understand	CLO6	CAME525.06
3	What are the performance indices of a solar collector?	The performance indices of a solar collector are Collector Efficiency is defined as the ratio of the energy actually absorbed and transferred to the heat transport fluid by the collector(useful energy) to the energy incident on the collector Concentration Ratio is defined as the ratio of the area of aperture of the system to the area of the receiver. The aperture of the system is the projected area of the collector facing (normal) the beam. Temperature Range is the range of temperature to which the heat transport fluid is heated up by the collector.	Understand	CLO7	CAME525.07
4	Name the basic design of solar cookers	The four basic designs of the solar cookers are: Box type solar cooker Dish type solar cooker Community solar cooker Advanced solar cooker	Remember	CLO8	CAME525.08
5	What is meant by solar photo voltaic	The direct conversion of solar energy into electrical energy by means of the photovoltaic effect, that is, the conversion of light (or other electromagnetic radiation) into electricity. The photovoltaic effect is defined as the generation of an electromotive force as a result of the absorption of ionizing radiation.	Understand	CL04	CAME525.04
6	List the application of solar PV system.	Water pumping sets for micro irrigation and drinking water supply Radio beacons for ship navigation at ports Community radio and television sets Cathodic protection of oil pipe lines Weather monitoring Railway signaling equipment Battery charging Street lighting.	Understand	CLO9	CAME525.09
7	What are the advantages &	Advantages Direct room temperature conversion of light to electricity through	Remember	CLO9	CAME525.09

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
	disadvantages of PV solar energy conversion system	a simple solid state device. Absence of moving parts Maintenance cost is low s they are easy to operate Do not create pollution Long effective life Highly reliable Disadvantages High cost In many applications energy storage is required because of no insolation at night.			
8	What are the advantages of concentrating collectors over flat plate type collectors	Advantages: Reflecting surfaces required less material and are structurally simpler than flat plate collectors. For a concentrator system the cost per unit area of solar collecting surface is therefore potentially less than that for flat plate collectors The absorber area of a concentrator system is smaller than that of a flat plate system for same solar energy collection and therefore the insulation intensity is greater. Little or no anti-freeze is required to protect the absorber in a concentrator system whereas the entire solar energy collection surface requires anti-freeze protection in a flat plate collector.	Understand	CLO9	CAME525.09
9	Name the types of concentrating collectors.	The main types of concentrating collectors are: Parabolic trough collector Mirror strip reflector Fresnel lens collector Flat plate collector with adjustable mirrors compound parabolic concentrator(CPC)	Understand	CLO8	CAME525.08
10	Discuss the principle of photovoltaic conversion of solar energy.	Conversion of light energy in electrical energy is based on a phenomenon called photovoltaic effect.	Remember	CLO3	CAME525.03
11	Summarize applications of photovoltaic	battery charger, domestic lighting, street lighting, water pumping	Understand	CLO9	CAME525.09
12	Summarize the solar radiation measurements	Thermopile is generally used. radiometers used for ordinary observation are pyrheliometers and pyranometers.	Understand	CLO13	CAME525.13
13	How is solar radiation measured	A pyranometer is a type of actinometer used for measuring solar irradiance on a planar surface and it is designed to measure the solar radiation flux density (W/m ²) from the hemisphere above within a wavelength range 0.3 μ m to 3 μ m.	Remember	CLO13	CAME525.13
14	What is flat plate collector	A typical flat-plate collector is a metal box with a glass or plastic cover (called glazing) on top and a dark-colored	Understand	CLO13	CAME525.13

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
		absorber plate on the bottom. The sides and bottom of the collector are usually insulated to minimize heat loss.			
15	Explain the process of desalination	Desalination is a process that takes away mineral components from saline water. More generally, desalination refers to the removal of salts and minerals.	Understand	CLO13	CAME525.13

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code			
		UNIT-V						
	CONCENTRATION OF SOLAR ENERGY, ENERGY STORAGE							
1	Explain how concentrated solar power system works.	Concentrated solar power (also called concentrating solar power, concentrated solar thermal, and CSP) systems generate solar power by using mirrors or lenses to concentrate a large area of sunlight, or solar thermal energy, onto a small area. Electricity is generated when the concentrated light is converted to heat, which drives a heat engine (usually a steam turbine) connected to an electrical power generator or powers a thermochemical reaction	Understand	CLO13	CAME525.13			
2	Explain trough or linear collector.	Linear concentrating collector fields consist of a large number of collectors in parallel rows that are typically aligned in a north- south orientation to maximize annual and summer energy collection. With a single- axis sun-tracking system, this configuration enables the mirrors to track the sun from east to west during the day, which ensures that the sun reflects continuously onto the receiver tubes.	Understand	CLO14	CAME525.14			
3	Summarize about central receiver.	The central receiver systems send concentrated light onto a remote central receiver. A typical example of such a system is a solar power tower system, which consists of multiple tracking mirrors (heliostats) positioned in the field around a main external receiver installed on a tower. Such systems are capable of reaching of much higher levels of concentration than linear systems. Concentrated radiation is further used as heat to produce steam and convert it to electricity (like in a regular power plant), or the generated thermal energy can be stored in a molten salt storage.	Remember	CLO16	CAME525.16			
4	Explain about parabolic dish concentrator with	Parabolic dish geometry concentrates light in a single focal point, i.e., all sun rays that are parallel to the axis of the	Understand	CLO15	CAME525.15			

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
	on axis tracking	parabola are directed towards the central receiver. This allows this type of collector to achieve the highest concentration ratios among all other type of solar collectors.			
5	Discuss how solar thermal electricity used stirling engine.	Solar energy is one of the famous renewable energy sources that can be used as an input energy source for Stirling engine. Solar Stirling systems convert the thermal energy in solar radiation to mechanical energy and then to electrical energy. Solar Stirling systems have demonstrated the highest efficiency of any solar power generation system by converting nearly 30% of direct-normal incident solar radiation into electricity after accounting for parasitic power losses Solar	Understand	CLO15	CAME525.15
6	How stirling system produces electricity.	Stirling system produces electricity by using parabolic collector and Stirling engine. Dish/Stirling concentrating solar power (CSP) converts solar heat into electricity by focusing solar radiation onto a receiver containing a heat-engine known as a Stirling engine	Remember	CLO15	CAME525.15
7	Define heliostat	A heliostat is a device that includes a mirror, usually a plane mirror, which turns so as to keep reflecting sunlight toward a predetermined target, compensating for the sun's apparent motions in the sky. The target may be a physical object, distant from the heliostat, or a direction in space	Understand	CLO15	CAME525.15
8	Explain solar photovoltaic's with concentration	Concentrator photovoltaics (CPV) (also known as Concentration Photovoltaics) is a photovoltaic technology that generates electricity from sunlight. conventional photovoltaic systems, it uses lenses and curved mirrors to focus sunlight onto small, but highly efficient, multi-junction (MJ) solar cells.	Understand	CLO4	CAME525.04
9	Discuss the necessity of solar energy.	Energy storage plays an important role in this balancing act and helps to create a more flexible and reliable grid system.	Remember	CLO15	CAME525.15
10	Explain how solar is used as chemical	Thermal energy from the sun can be	Understand	CLO14	CAME525.14

S.No	QUESTION	ANSWER	Blooms Level	CLO	CLO Code
	energy storage.	stored as chemical energy in a process called solar thermochemical energy storage (TCES). The thermal energy is used to drive a reversible endothermic chemical reaction, storing the energy as chemical potential.			
11	Explain how solar energy is used for thermal energy.	Solar thermal energy in this system is stored in the same fluid used to collect it. Fluid from the low- temperature tank flows through the solar collector or receiver, where solar energy heats it to a high temperature, and it then flows to the high-temperature tank for storage.	Remember	CLO13	CAME525.13
12	Define thermal flywheel effect.	In building design, thermal mass is a property of the mass of a building which enables it to store heat, providing "inertia" against temperature fluctuations. It is sometimes known as the thermal flywheel effect.	Understand	CLO13	CAME525.13
13	Explain about recharge batteries.	A rechargeable battery, secondary cell or accumulator is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use.	Remember	CLO15	CAME525.15
14	What is a battery.	A battery is an electrochemical cell (or enclosed and protected material) that can be charged electrically to provide a static potential for power or released electrical charge when needed. A battery generally consists of an anode, a cathode, and an electrolyte.	Understand	CLO15	CAME525.15
15	Define compressed air	Compressed air is air kept under a pressure that is greater than atmospheric pressure. Compressed air is an important medium for transfer of energy in industrial processes.	Understand	CLO15	CAME525.15

Signature of the Faculty

Signature of HOD