

SOLUTION - RENEWABLE ENERGY SOURCES – INTERNAL TEST1

SUBJECT CODE : 10EE836

SEMESTER : 8 A

Answer any five full questions. Each question carries 10 Marks :

1. Non - Renewable Energy sources are cheaper than renewable energy sources. Here storage is easy and convenient. These sources are very convenient to use as technology for their conversion and their use is universally available. Fossil fuels generate pollutants. Coal is a valuable petrochemical and is used as raw material for chemical, pharmaceutical and paint industries. It is desirable to conserve coal for future needs. Safety of nuclear power plants is important. The waste material generated in nuclear plants has radioactivity quotients of dangerous levels. There is a possibility of accidental leakage of radioactive material from reactor. Uranium resource has a limited availability. Sophisticated technology is required for using nuclear resources.

Renewable energy sources are available in nature free of cost. They produce very little pollution. They are environment friendly. They are inexhaustible. They have a low gestation period. The energy is available in dilute form from these sources. The cost of harnessing energy from non – conventional sources is generally high. Availability is uncertain. The energy flow depends on various natural phenomena beyond human control. There is difficulty in transporting such forms of energy. (10 Marks)

2. The earth's atmosphere contains various gaseous constituents, suspended dust and other minute solid and liquid matter. These are air molecules, ozone, oxygen, nitrogen, carbon dioxide, carbon monoxide, water vapour , dust and water droplets. Therefore solar radiation is depleted during its passage through the atmosphere. (2 Marks)

Absorption – Selective absorption of various wavelengths occurs by different molecules. Nitrogen and molecular oxygen absorb X – rays and extreme ultraviolet radiations. Ozone absorbs a significant amount of ultraviolet radiation in the range (wavelength < 0.38 μ m). Water vapour and

carbon dioxide absorb almost completely the infrared radiation. Dust particles and air molecule also absorb a part of solar radiant energy irrespective of wavelength. (3 Marks)

Scattering – Scattering by dust particle and air molecules involves redistribution of incident energy. A part of the scattered radiation is lost to space and remaining is directed downwards to the earth's surface from different directions as diffuse radiation. It is this scattered sunlight that makes the sky blue. (2 Marks)

Diagram – (3 Marks)

3. World Energy Consumption is the Total energy used by all of human civilization . Typically measured per year it involves all energy harnessed from every single source across every single industrial and technological sector across every country. Fossil Fuels are so called because these are the fossils of old biological life that once existed on the surface of the earth. (2 Marks)

It is formed in several parts of the earth at varying depths, during several million years by slow decomposition and chemical actions of buried organic matter under favourable pressure, heat and bacterial marine environment. The fossil fuels include coal, oil and gas. The Fossil fuels have been a major source of energy since about 1850, the start of the industrial era. The 20th century saw a rapid twenty – fold increase in the use of fossil fuels. (3 Marks).

In 2000, China accounted for 28% of world coal consumption, other Asia consumed 19% and North America 25%. The single greatest coal consuming country is China. Its share of the world coal production was 28% in 2000 and rose to 48% in 2009. (2 Marks)

Hydroelectricity is the term referring to electricity generated by hydro power, the production of electrical power through the use of kinetic energy of falling or flowing water. In 2015 hydro – power generated 16.6% of the world's total electricity and 70% of all renewable electricity which continues the rapid rate of increase experienced between 2003 and 2009. China is the largest hydroelectricity producer representing around 17% of domestic electricity use.

(3 Marks)

4. Solar constant - The solar constant, a measure of flux density, is the mean solar electromagnetic radiation (the solar irradiance) per unit area that would be incident on a plane perpendicular to the rays, at a distance of one astronomical unit from the Sun . The solar constant includes all types of solar radiation , not just the visible light.

Air mass ratio – It is the ratio of the path length traversed by beam radiation to the vertical path length of the atmosphere. The path length of a solar beam through the atmosphere is accounted for the term air mass. At sea level air mass is unity.

Solar Azimuth angle(γ_s) - It is the angle on a horizontal plane between the line due south and the projection of the sun's ray on the horizontal plane. It is taken as positive when measured from south towards west.

Zenith angle, θ_z -It is the angle between the sun's ray and the perpendicular(normal) to the horizontal plane. The zenith angle is the angle between the sun and the vertical.

Latitude(Angle of Latitude), (ϕ) - The Latitude of a location on the earth's surface is the angle made by the a radial line joining the given location to the center of the earth with its projection on the equator plane. The Latitude is positive for Northern hemisphere and negative for Southern hemisphere.

Each definition carries 2 Marks. Total 10 Marks.

5. Pyranometer : A Pyranometer is designed to measure global radiation usually on a horizontal surface, but can also be used on an inclined surface. When shaded from beam radiation by using a shading ring, a Pyranometer measures diffused radiation. A Pyranometer is used for measuring solar irradiance on a planar surface. It is designed to measure the solar radiation flux density (W/m^2) from the hemisphere above within a wavelength range $0.3 \mu m$ to $3 \mu m$. The name Pyranometer is derived from pyr, meaning “fire” and ano meaning “above sky”. A typical Pyranometer does not require any power to operate. A radiation shield surrounding the outer dome and coplanar with the sensing element, prevents direct solar radiation from

heating the base of the instrument The instrument has a voltage output of approximately $9\mu\text{V/W/m}^2$ and has an output impedance of 650Ω . The pyranometer when provided with a shadow band to prevent beam radiation from reaching the sensing element measures the diffused radiation only. (6 Marks) Diagram – 4 Marks.

6. For June 21, $n = 31 + 29 + 31 + 30 + 31 + 21 = 173$

December 21, $n = 31 + 29 + 31 + 30 + 31 + 30 + 21 = 356$ (2) Marks

For June 21

$$\delta = 23.45 \sin[360/365 (284 + n)] = 23.45^\circ$$

For December 21

$$\delta = 23.45 \sin[360/365(284 + 356)] = -23.45^\circ \quad (4) \text{ Marks}$$

For June 21

$$t_d = (2/15) \cos^{-1}[-\tan 12.97^\circ \tan 23.45^\circ]$$

For December 21

$$t_d = (2/15) \cos^{-1}[-\tan 12.9686^\circ \tan -23.45^\circ] = 11.23 \quad (4) \text{ Marks}$$

7. December 1

$$n = 335$$

$$\delta = 23.45 \sin[360/365(284 + n)] = -22.11^\circ$$

$$\beta = 36^\circ, \quad \varphi = 28^\circ 38' = 28.63^\circ, \quad \gamma = 0 \quad (5) \text{ Marks}$$

$$W = [\text{Solar Time} - 12.00] \text{ in hours} \times 15^\circ = (9 - 12) \times 15 = -45^\circ$$

$$\cos \theta_i = \sin \delta \sin(\varphi - \beta) + \cos \delta \cos \varphi \cos(\varphi - \beta) = \sin -22.11^\circ \sin(28.63^\circ - 36^\circ) + \cos -22.11^\circ \cos -45^\circ \cos(28.63^\circ - 36^\circ)$$

$$\theta_i = 45.7^\circ \quad (5) \text{ Marks}$$