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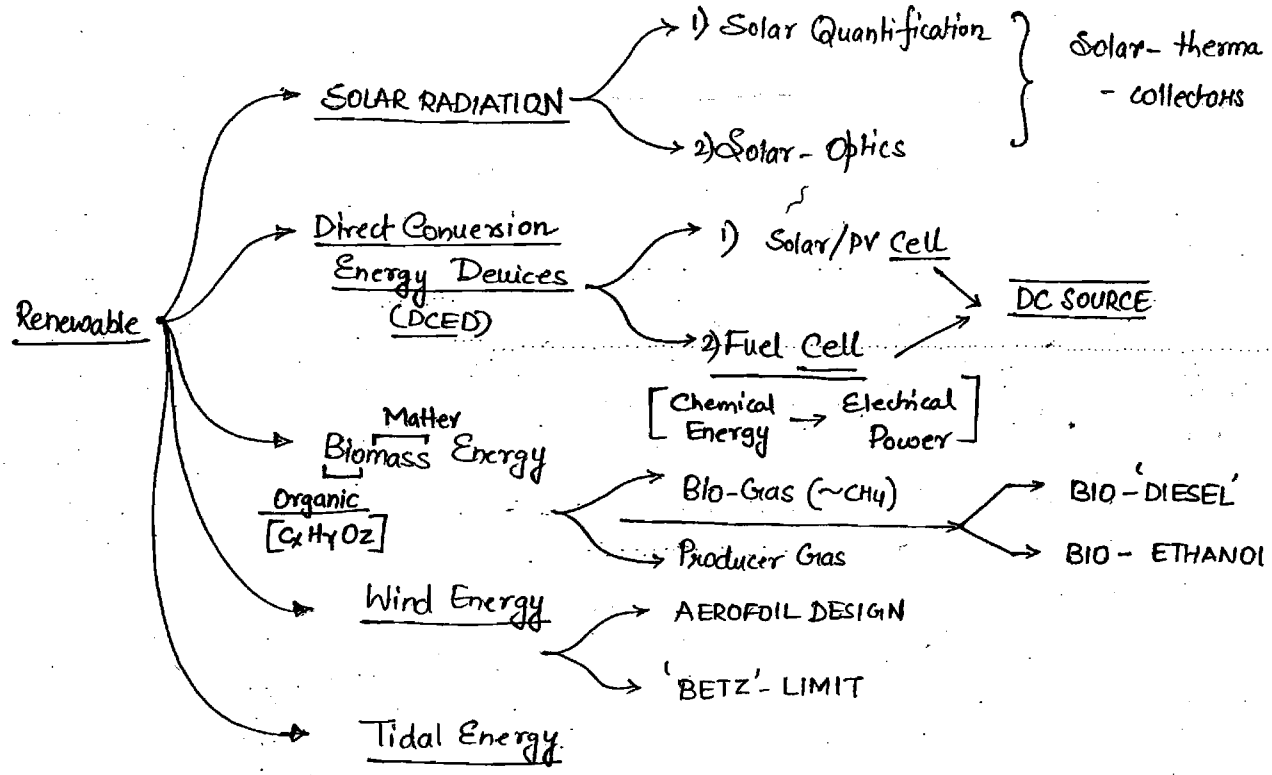
Renewable



Renewable - Renewable is the term used for those energies which flow naturally, repeatedly, and infinite source of energy w/o any emissions.

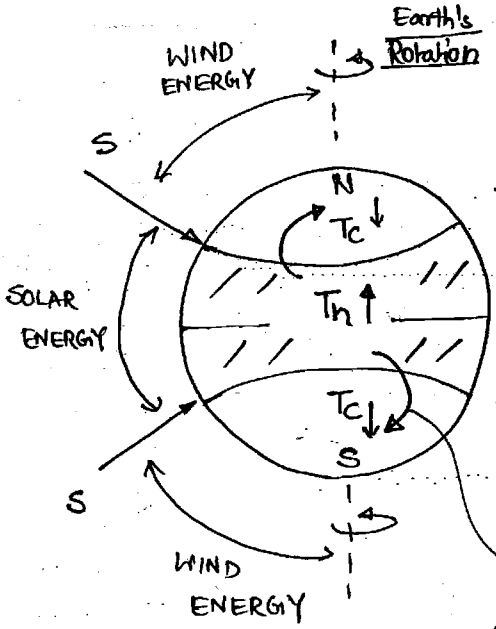
Advantages:

1) Availability - Over the wide geographical area.
2) Infinite source - Continuously available for large time.
3) Green Energy - No emissions.
4) Negligible running cost -

Disadvantages -

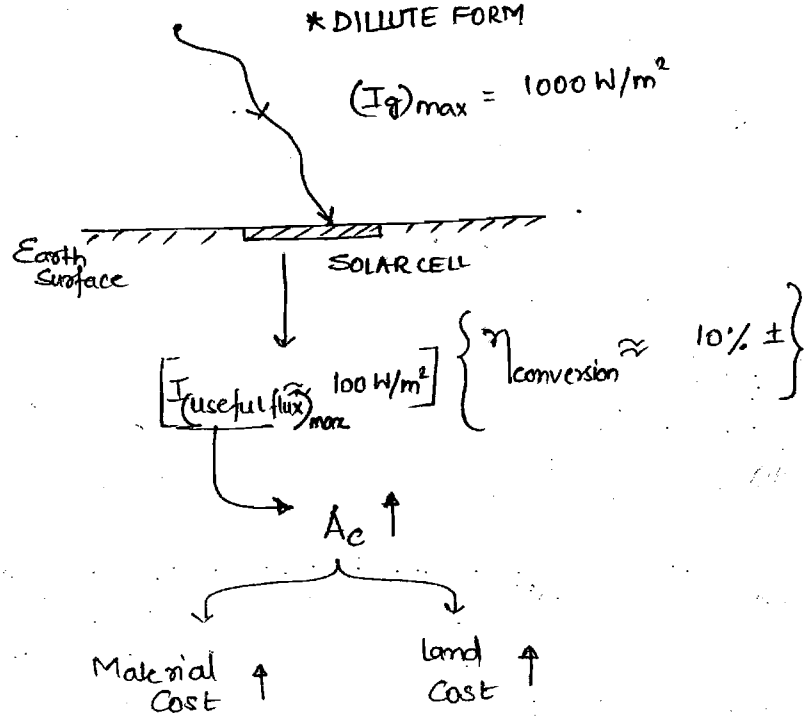
1) Dilute form of energy.
2) Unpredictable and intermittent - Highly weather dependent function.

3) High Initial / Installation Cost.



due to :

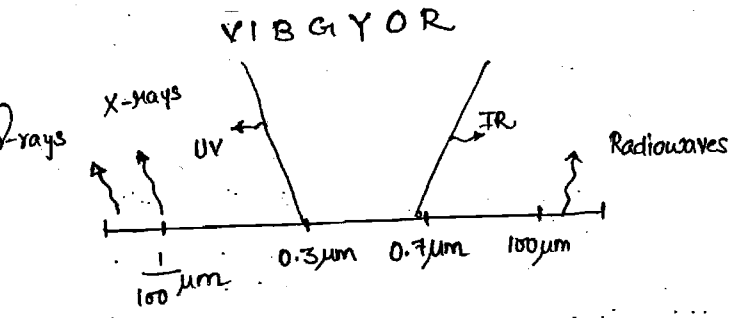
1) temp difference
2) earth's rotation.

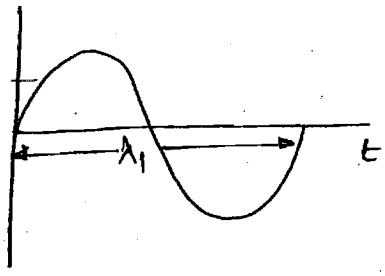


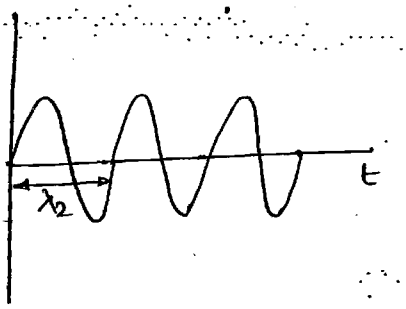
Solar Quantification

1) Wave Theory:

If wavelength λ is less (short wave), it means frequency will be more hence no. of collisions in the same thickness of the material will be higher or penetration depth will be more.







[$\lambda \uparrow \Rightarrow \gamma \downarrow \Rightarrow$ No. of collision $\downarrow$ ⇓ Penetration depth $\downarrow$]

$T\downarrow \Leftarrow$ (Temp of source) $\Leftarrow$ Travelling Distance $\downarrow$

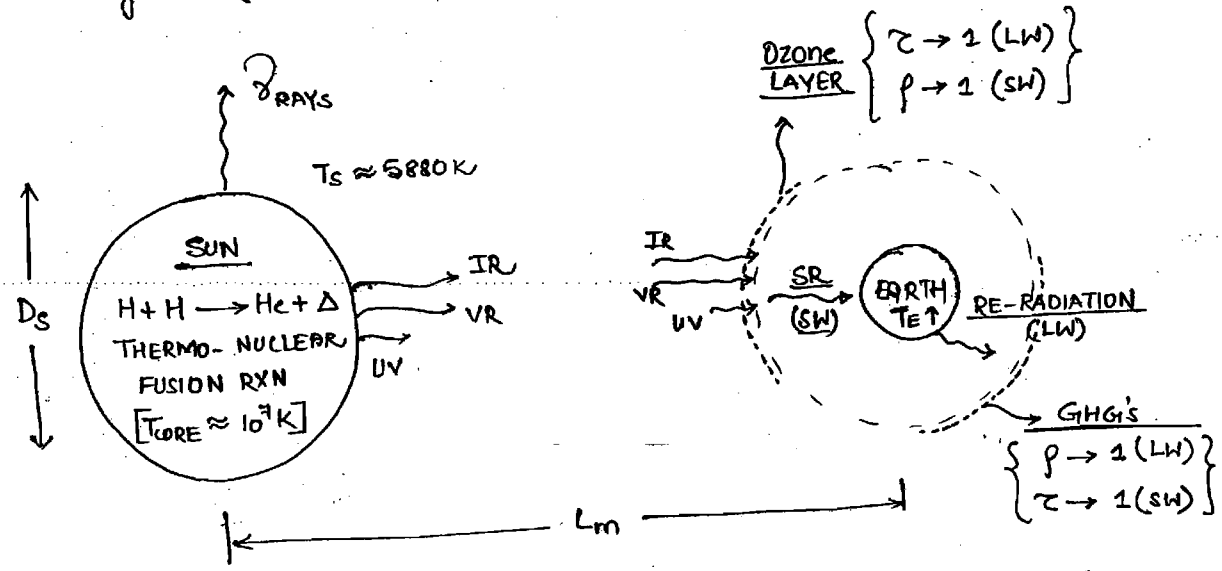
LONG SOURCE

2) Spectral Distribution of Solar Radiation

i) Sun, being at very high temp because of nuclear fusion rxn of hydrogen atom and due to which it release solar radiation in every possible direction (diffusive body) and assumed to be a black body.

Note: 1) Solar flux is non uniformly distributed over a wavelength range in which it covers entire range of visible radiation and some part of UV & IR.

Note 2) The maximum spectral emissive power is in the ~~xx~~ VR ~~range~~ region (Wien's Displacement law).



$$\left[\begin{array}{l} D_E = 1.3 \times 10^4 \text{ km} \\ D_S = 1.4 \times 10^6 \text{ km} \\ L_m = 1.5 \times 10^8 \text{ km} \end{array}\right]$$

$$E_\lambda = f(\lambda, T)$$

PLANK'S DISTRIBUTION LAW:

$$E_{\lambda,b} = \frac{C_1}{\lambda^5 \left[e^{C_2/\lambda T} - 1\right]} \quad ; \; C_1, C_2 \Rightarrow \text{constants.}$$

Wien's Displacement Law:

$$\lambda_m \cdot T = 2898 \, \mu m\text{-}K$$

Stefan - Boltzmann Law

$$E_b = \int_0^\infty E_\lambda \, d\lambda = \int_0^\infty \frac{C_1}{\lambda^5 \left[e^{\frac{C_2}{\lambda T}} - 1\right]} \, d\lambda$$

$\Rightarrow E_b = \sigma T^4$.

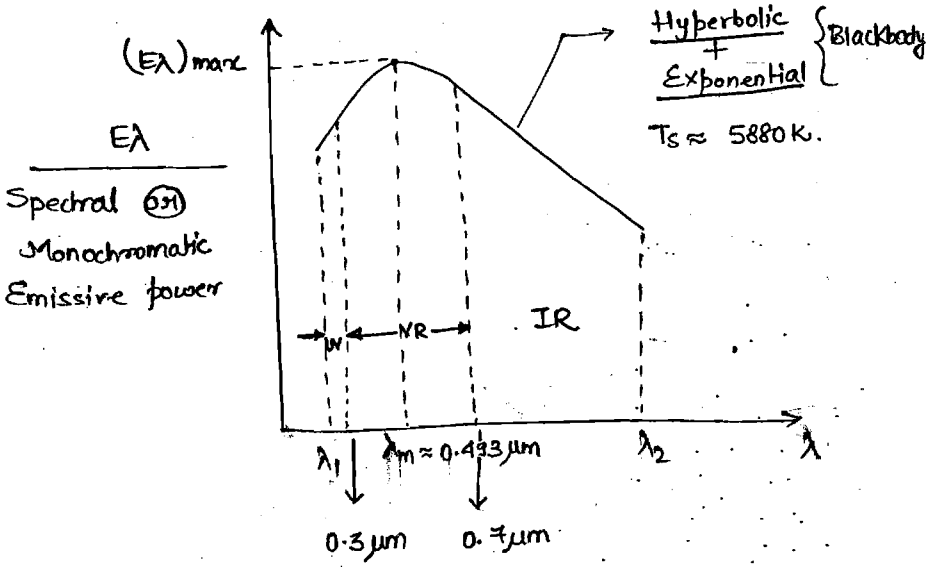
↳ Stefan-Boltzmann Constant

Kirchoff's Law:

$E = \varepsilon \sigma T^4$.

$\varepsilon = \alpha$

[Thermal Equilibrium]



$E\lambda$

Spectral (or) Monochromatic Emissive power

WDL

$\lambda_m \cdot T_s = 2898$

$\lambda_m = \frac{2898}{5880}$ { for solar radiation }

$= 0.493 \mu m$.

Note:

1) Solar radiation covers entire Electromagnetic spectrum — False

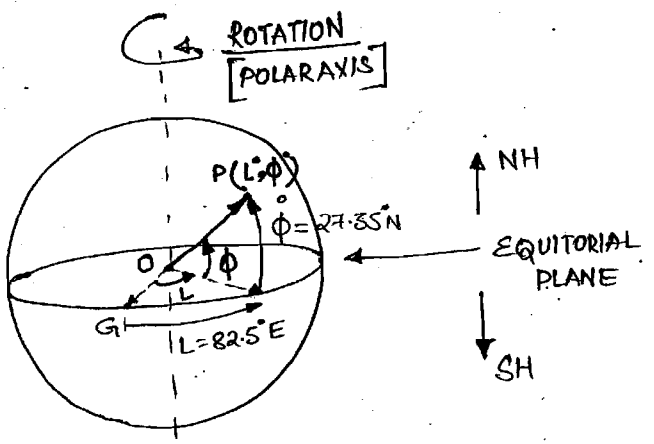
2) Electromagnetic spectrum covers entire solar radiation — True.

Geometrical effect on solar radiation :

Longitude (L) - It is an angle measured from the Greenwhich, UK to the projection of the radial line on the equitorial plane.

Radial line - Line joining the location with the centre of the earth on ~~the equitorial plane~~

Latitude (ϕ) - It is an angle measured from the radial line to its projection on the equitorial plane in either Northern Hemisphere or Southern Hemisphere.

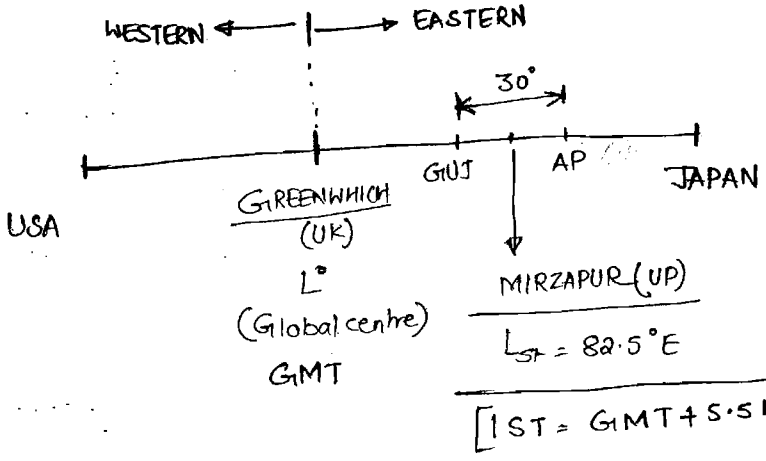


TIME CONVERSION

360° — 24 h
15° — 1 hr
15° — 60 min
1° — 4 min

SPHERE

(R, Θ, ϕ)
(fixed) L°



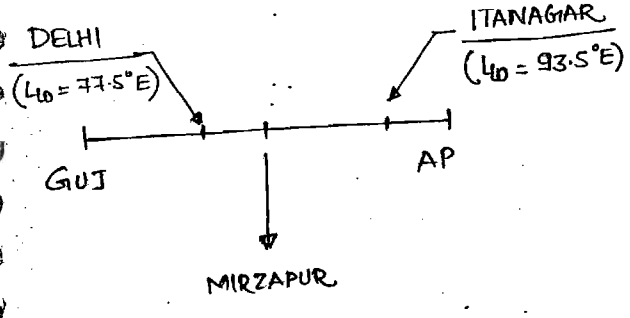
TIME CALCULATIONS:

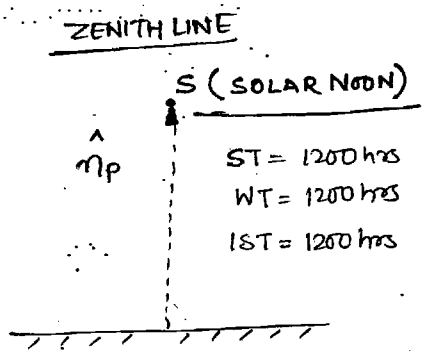
SOLAR NOON – When Sun is at the zenith or overhead at a particular location then the time is termed as Solar Noon.

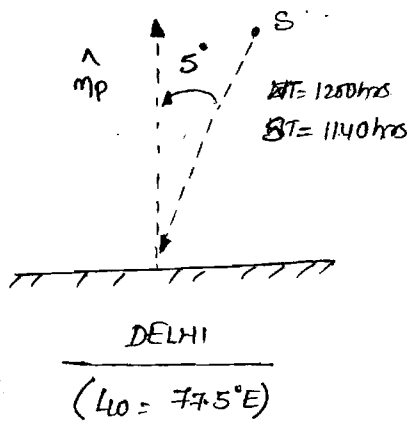
SOLAR TIME (ST) or Local Apparent Time (LAT):

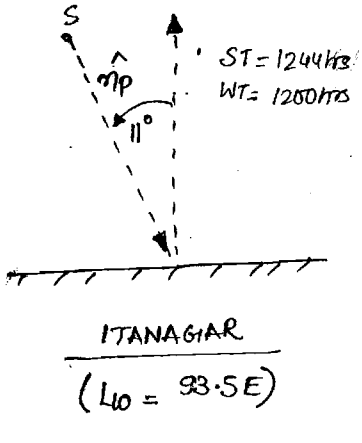
The time according to the Sun location is termed as Solar Time or the time which is according to the standard location longitude of the country is termed as Watch Time (WT).

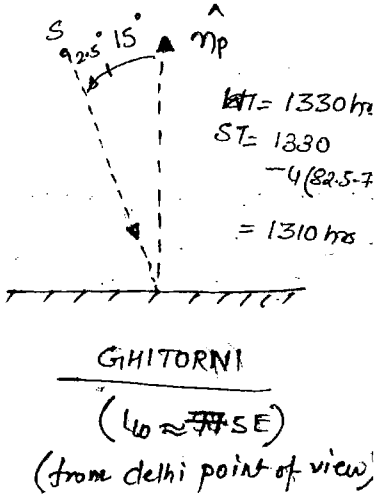
$$ST = WT - \frac{4(L_{st} - L_{lo})}{MIN}$$





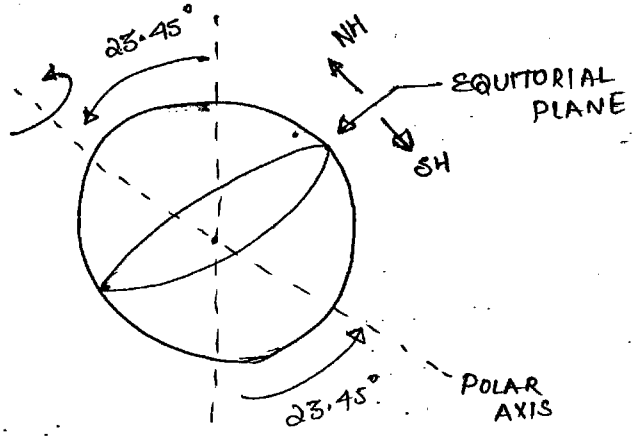


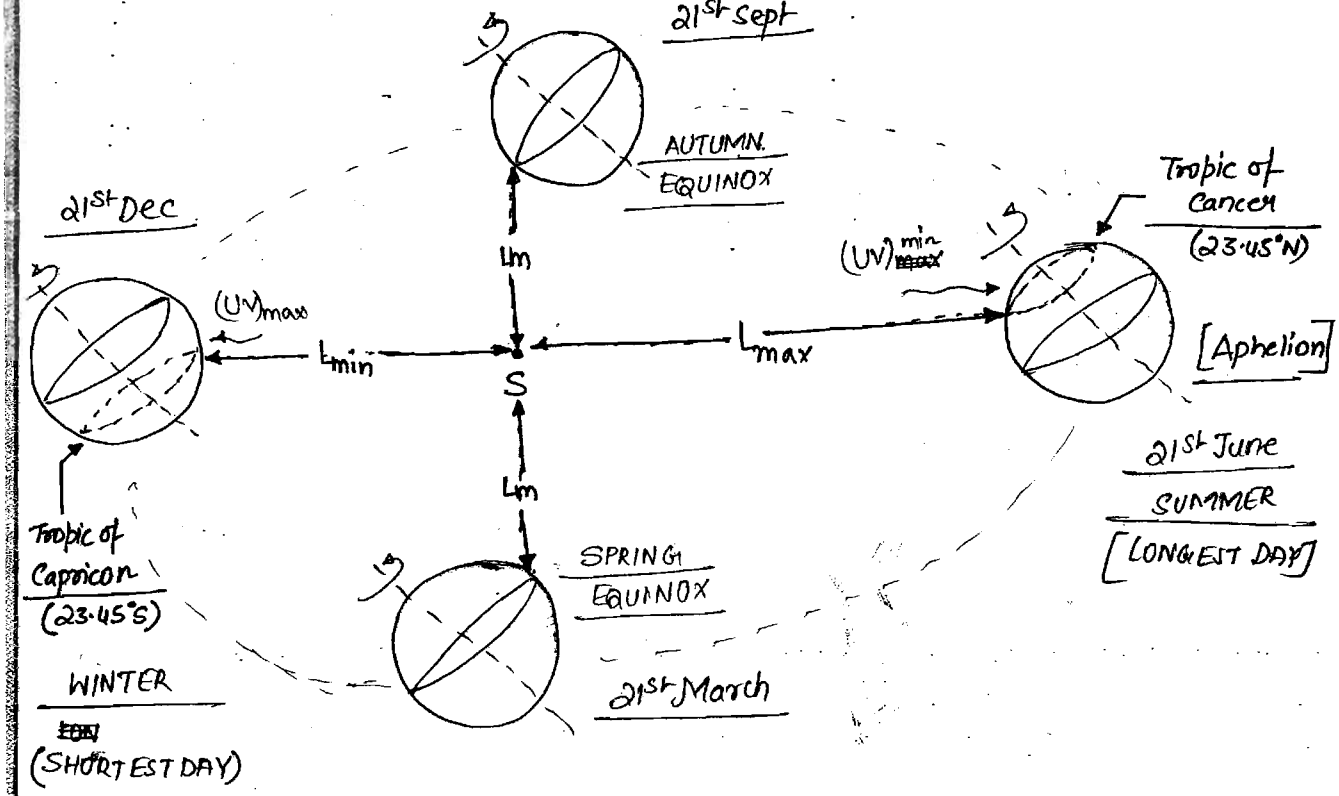




TILTING OF THE EARTH:

Due to the tilting of the earth, there is formation of seasons and as the earth revolves around the sun in the elliptical orbit hence the distance b/w the earth and sun varies which varies the solar radiation flux magnitude and its distribution.





INCIDENCE SOLAR RADIATION VARIATION:

SOLAR CONSTANT [Isc] - After the experimental studies, the energy flux incident from the Sun on the earth's atmosphere in the proper -lar direction when the distance b/w the Sun and earth is mean.

$$I_{sc} = 1367 \text{ Watt/m}^2$$

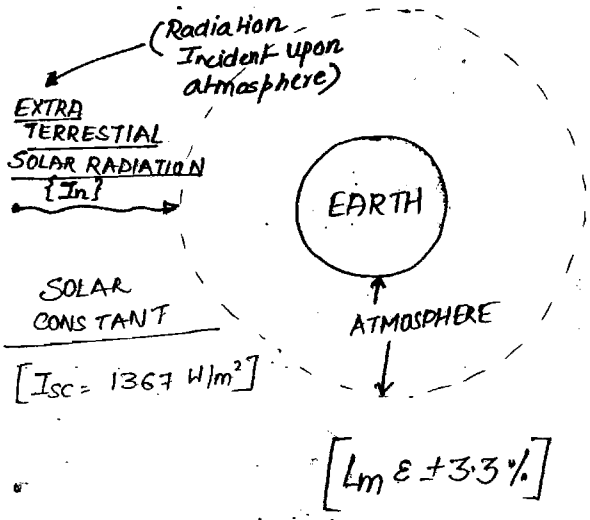
Note - Due to the elliptical orbit, the solar radiation flux incident on the earth's atmosphere becomes the function of the day numbe (n) and given as

$$I_n = I_{sc}\left\{1 + \underbrace{0.033}_{L_n \in [\pm 3.3\%]} \underbrace{\cos}_{[-1,0,1]}\left(\frac{360^\circ}{365} xn\right)\right\} \text{ W/m}^2$$

$n = 1 \rightarrow 1^{st}$ Jan

$= 365 \rightarrow 31^{st}$ Dec

[1 LANGLEY = 1 cal/m²]



21st March : n = 31+28+21 = 80

21st June : n = 172

$(I_n)_{min} = 1322 \text{ W/m}^2$

21st Dec : n = 355

$(I_n)_{max} = 1411 \text{ W/m}^2$

Environmental Effect On Solar Radiation :

Solar radiation received on the earth's surface are basically of two types

i) Beam or Direct Radiation (I_b) -

The total radiation flux that received on the earth's surface in line with the Sun direction

ii) Diffuse or Indirect Radiation (I_d) -

Solar radiation received on the earth's surface after getting Scattered or refracted or reflected due to the atmosphere which contains water vapour, dust particles etc.