Technical Module – III - AR 0303

CONSTRUCTION AND DETAILS

REFERENCE BOOKS

1. Manual of Tropical Housing and Building – Koenigsberger
2. Sun, Wind and Light: Architecture Design Strategies - Mark DeKay & G.Z Brown
3. Structures by Daniel Schodek
4. Elementary structures for Architects and Builders by Ronald E Schaeffer
5. McKay's Building Construction - William Barr McKay
6. Building Construction 20th Edition – Sushil Kumar

COURSE OBJECTIVE

To develop an understanding of different building systems coming together in a built form and further inquiry into how these systems inform each other. Also creating an understanding on Environmental system of Solar geometry and its effect on climate and sun angles.

COURSE CONTENT

Types of Building construction system

Types of Foundation & Walling system

Solar Geometry

Sun – Path Diagrams

Thermal comfort

LEARNING OUTCOME

Students will be able to develop an understanding of building systems and elements, while also developing an insight into making through various exercises.

BUILDING SYSTEMS

BUILDING COMPONENTS

ENCLOSER STRUCTURE SERVICES

ENCLOSER

Separate interior and exterior environments and helps in managing inside desired comfortable environment.

STRUCTURE

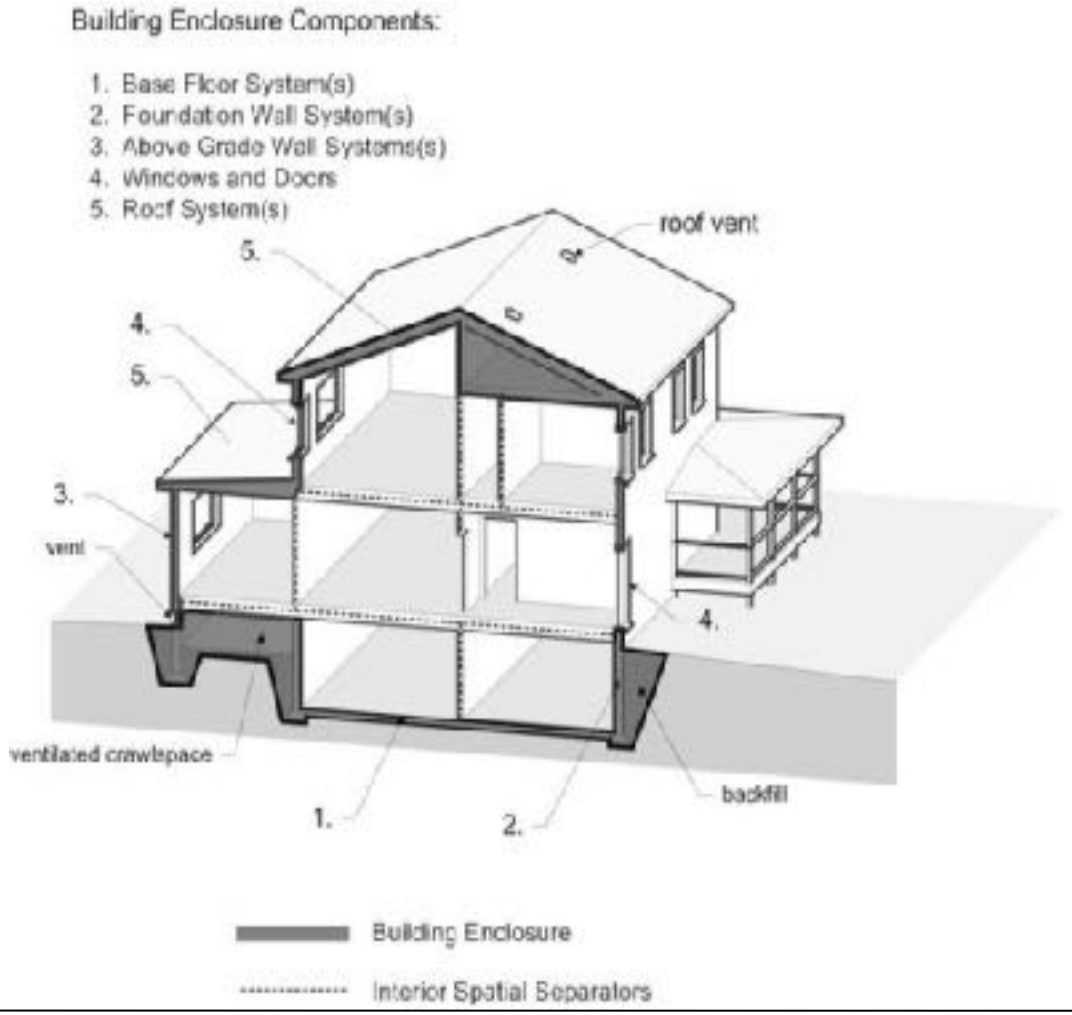
The load carrying part of all natural and man – made forms. It is the part which enables them to stand under their own weight and under the worst conditions of external applied forces.

SERVICES

System installed in the buildings to make them comfortable, functional, efficient and safe.

ENCLOSER

Separate interior and exterior environments and helps in managing inside desired comfortable environment.



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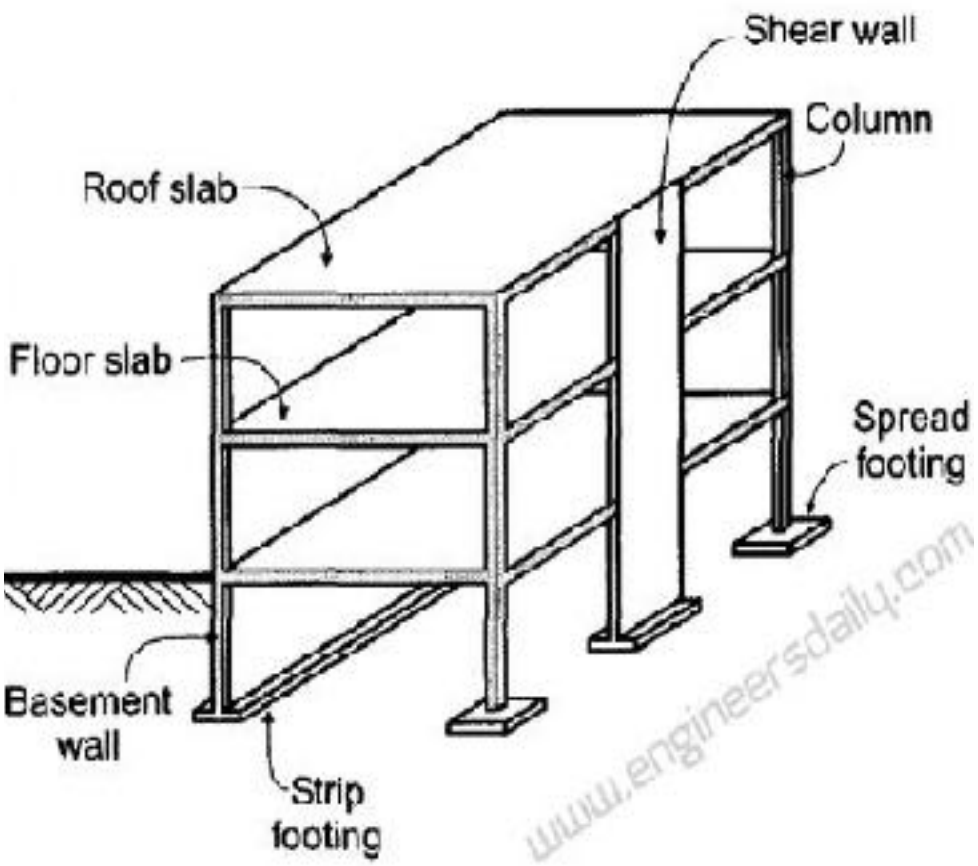

Image - www.engineersdaily.com

SERVICES

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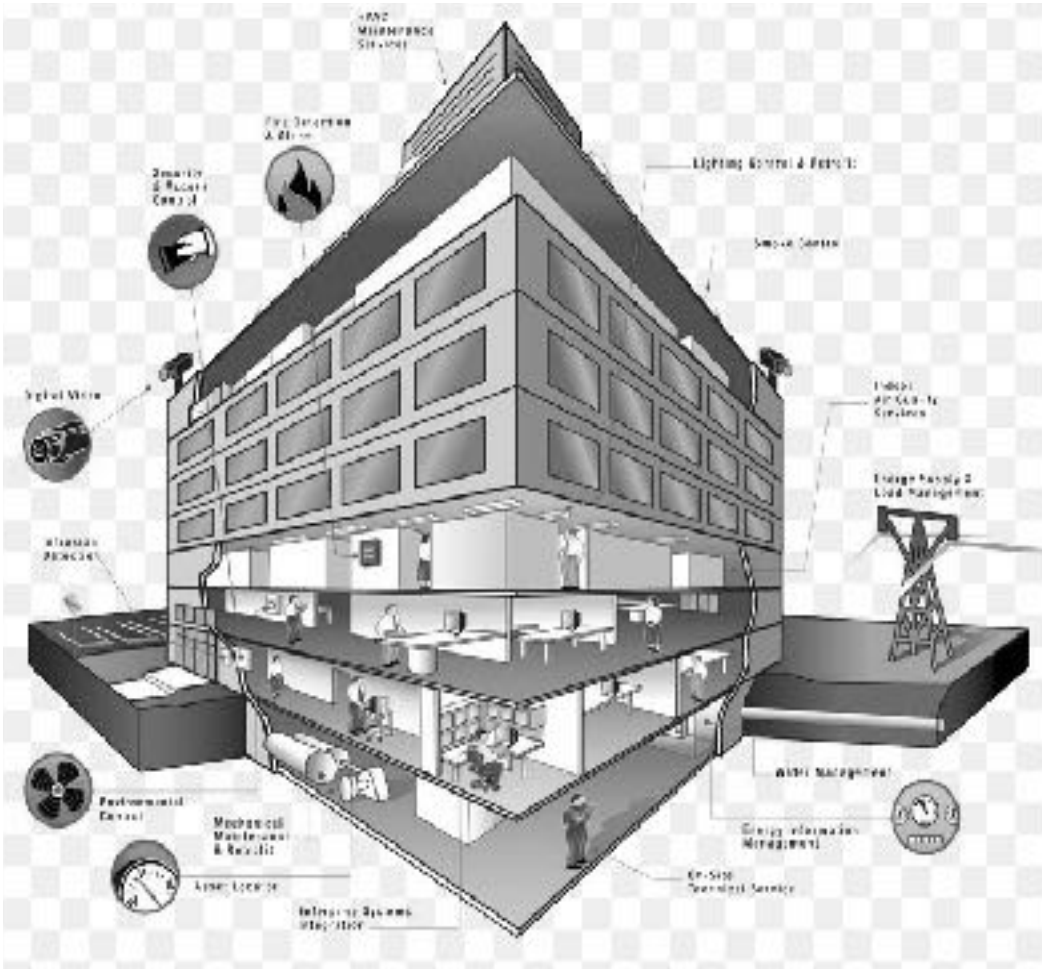


Image - https://www.civilquery.com/what-is-maintenance-in-a-building/

A system can be defined as an **assembly** of interrelated or interdependent parts forming a more complex and unified whole and serving a common purpose. A building can be understood to be the physical embodiment of a number of systems and subsystems that must necessarily be related, coordinated, and integrated with each other as well as with the three dimensional form and spatial organization of the building as whole.

BULK ACTIVE - System of horizontal and vertical structural elements for redistribution of forces

FORM ACTIVE - System of Flexible, non ridged matter, in which redirection of forces is effected by particular form design and characteristic form stabilization.

SURFACE ACTIVE - System of Flexible or ridged planes able to resist tension, compression or shear, in which redirection of forces is effected by surface resistance and particular surface form.

VECTOR ACTIVE - System of straight liner members in which the redirection of forces is effected by multi-directional splitting of forces into vectors along compressive and tensile elements

FOUNDATION TYPES

Shallow foundation – foundation where depth is less or equal to its width

Wall footing/Strip footing
Isolated footing
Combined footing
Cantilever/Strap beam footing
Mat/Raft footing

Deep foundation – foundation where depth is more to its width

End bearing pile
Friction pile

The size and depth of a foundation is determined by the structure and size of the building it supports and the nature and bearing capacity of ground supporting it

SOIL BEARING CAPACITY

The bearing capacity of soil is defined as the capacity of the soil to bear the loads coming from the foundation. The load spreads out within the footing itself at about a 45-degree angle, and then spreads out in the soil at a steeper angle, more like 60-degrees from the horizontal. As the load under a footing spreads out, pressure on the soil diminishes. Soil directly under the footing takes the greatest load, and therefore should be thoroughly compacted.

Because the load spreads out, the pressure on the soil is greatest right beneath the footing. By the time we get down below the footing a distance equal to the footings width, the unit soil pressure has dropped by about half. Go down the same distance again, and the pressure has dropped by two-thirds. So it's the soil right under the footing that is the most critical and also, typically, the most abused.

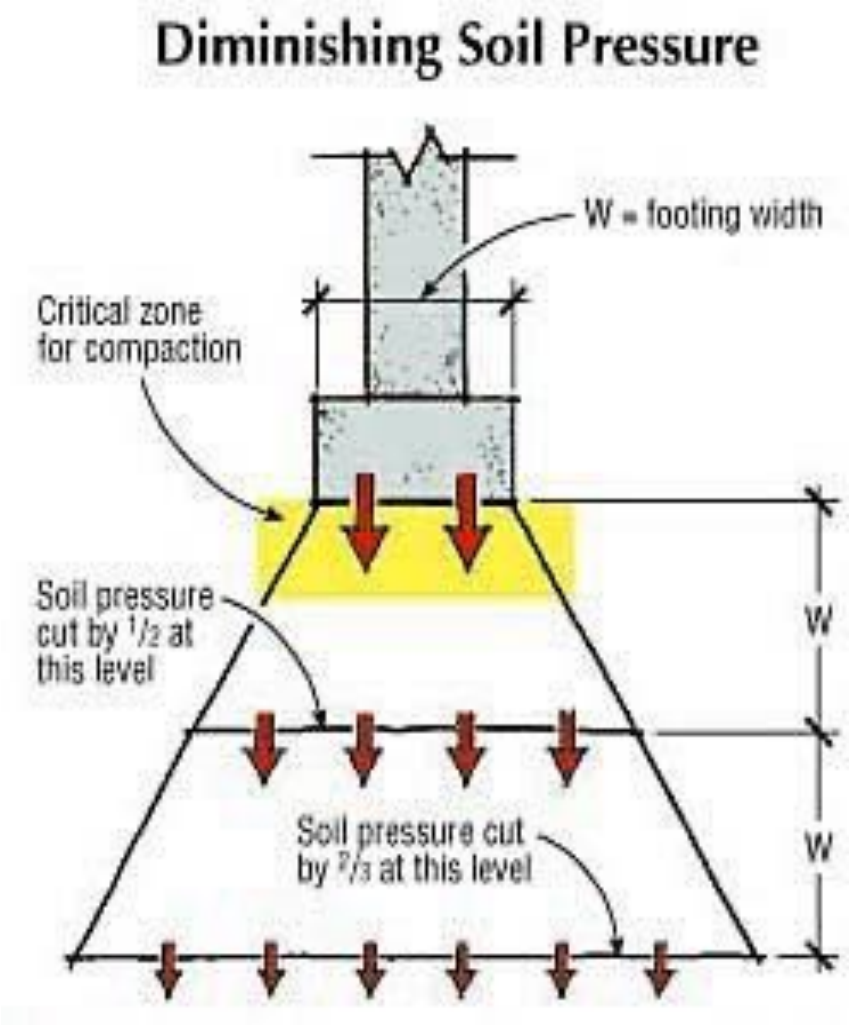


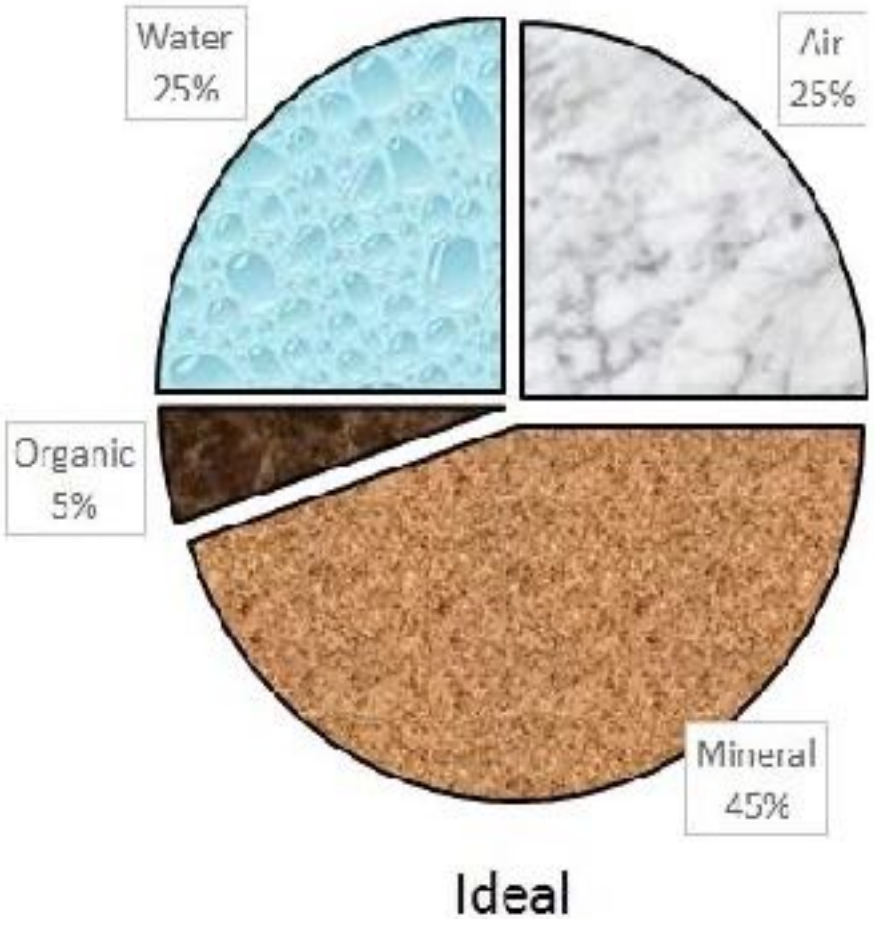
Image - https://www.concretenetwork.com/concrete/footing_fundamentals/why_soils_matter.htm

SOIL COMPOSITION

The soil consists of a mixture of **solid particles**, **water** and **air**. Solid particles can be **inorganic** or **organic**. The inorganic parts are mainly minerals: silicates, oxides and hydroxides of iron, aluminum, manganese, etc. that, according to their dimension, are classified in skeleton and fine earth, which are then divided into sand, lime and clay.

The degradation processes of vegetal residues (leaves, fruits, dry branches or whole plants) and dead animals lead to the creation of organic fractions of the soil

Water and air occupy the free spaces between solid particles (pores), and form a thick and extended network that allows water to move in the ground.



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CLIMATE

WEATHER **is the short-term atmospheric conditions of any particular place, day and time.** Although entire Earth's is covered by only one atmosphere, the weather is not the same all around the place. The weather may variate over minutes, hours and days in different places of the world.

Weather forecasting is observed by the Meteorological Department of any particular place, and the study is known as **Meteorology**.

CLIMATE is statistical weather information, that provides information about the average weather condition of a particular location over a long period of time, for the span of more than 30 years.

Climate is predicted by the Climate Prediction Centre and its study is known as **Climatology**.

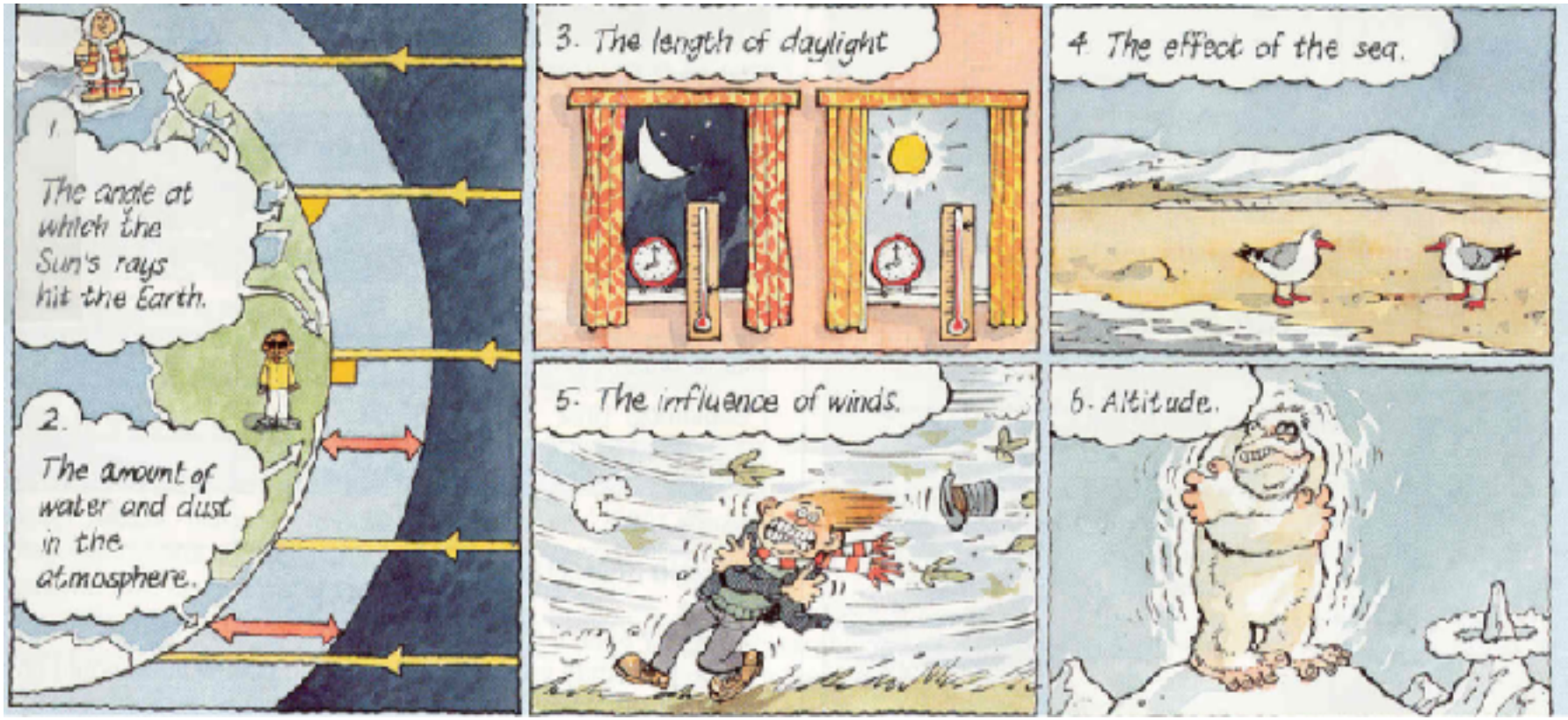


Image - https://nisis.weebly.com/3-factors-influencing-weather--climate.html

KOPPEN CLIMATE CLASSIFICATION SYSTEM –

German botanist and climatologist **WLADIMIR KOPPEN** – Classification is based on vegetation zones across the globe

KOPPEN CLIMATE CLASSIFICATION is a terrestrial classification of climatic zones into five major types represented by letters **A , B, C, D,** and **E**

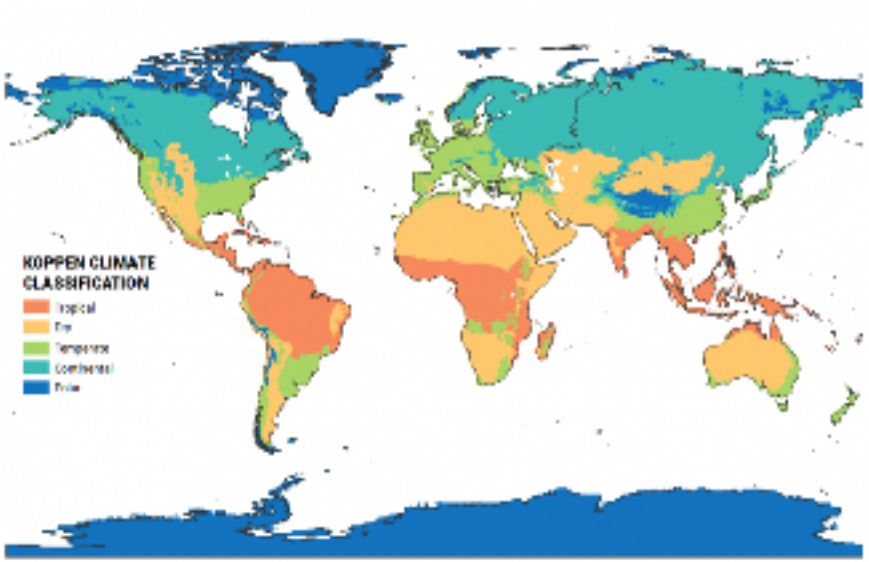
A – TROPICAL MOIST CLIMATES (average temperature above 18C in all months)

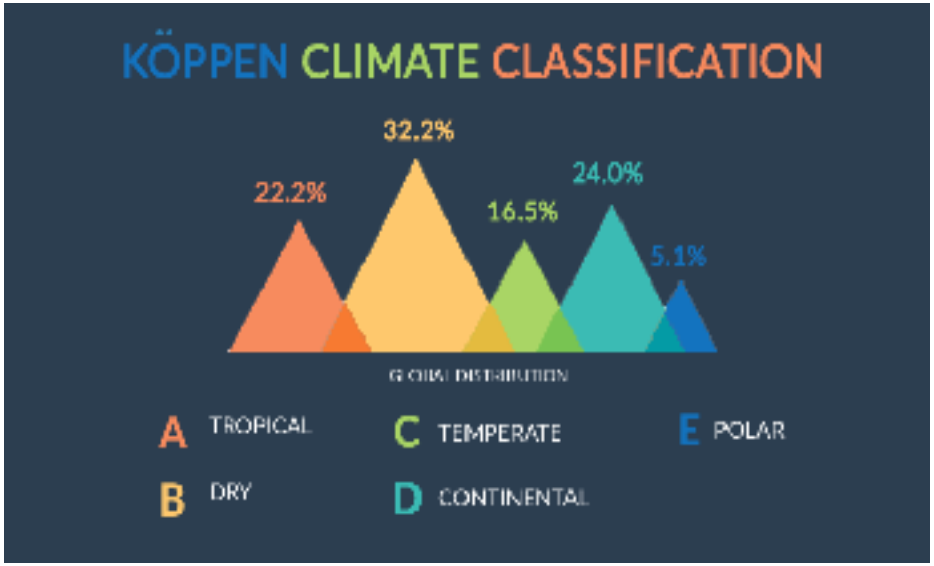
B – DRY CLIMATES (deficient precipitation for most of the year)

C – MOIST MID LATITUDE CLIMATES WITH MILD WINTERS

D – MOIST MID LATITUDE CLIMATES WITH COLD WINTERS

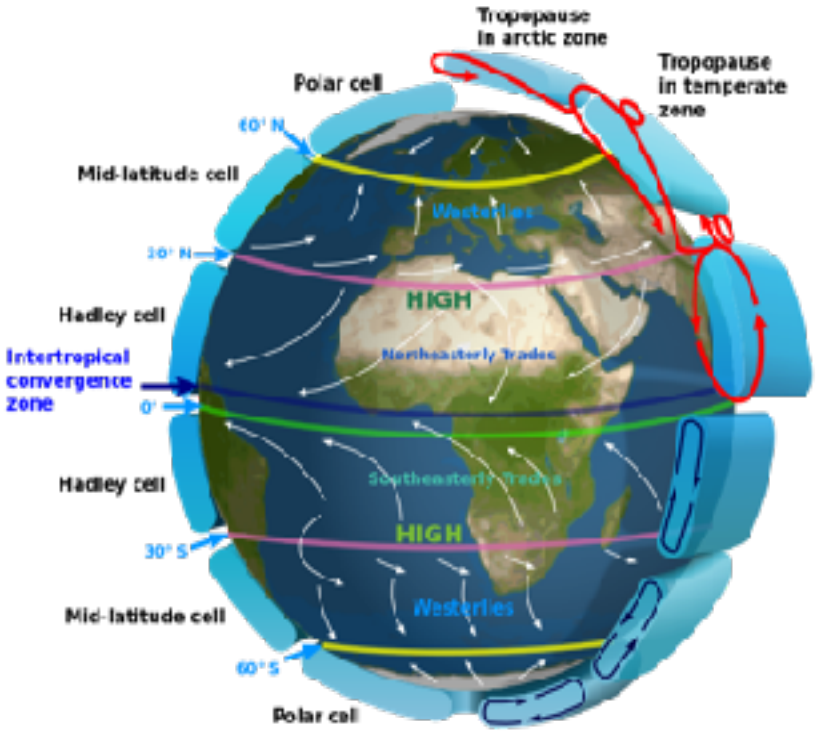
E – POLAR CLIMATES (extremely cold summers and winters)

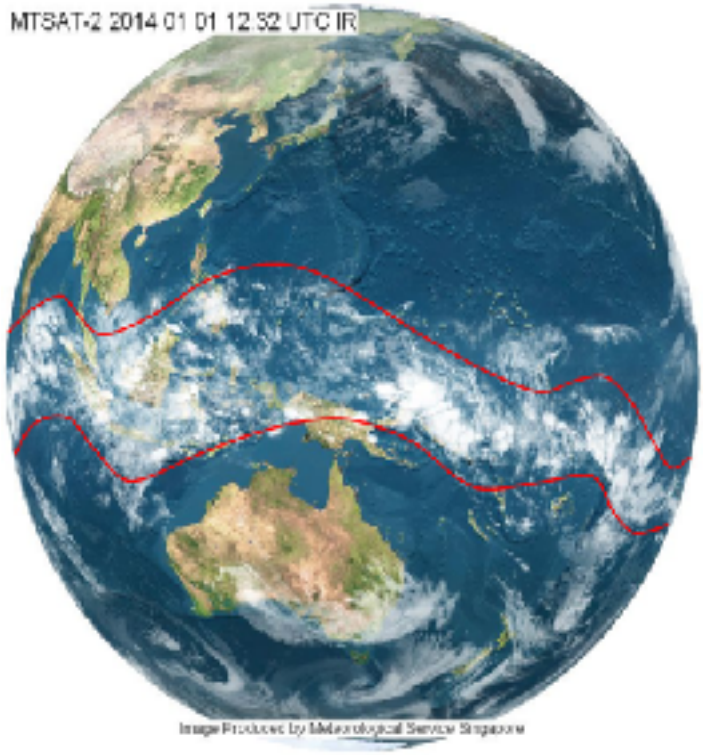




Source- https://earthhow.com/koppen-climate-classification/

INTERTROPICAL CONVERGENCE ZONE





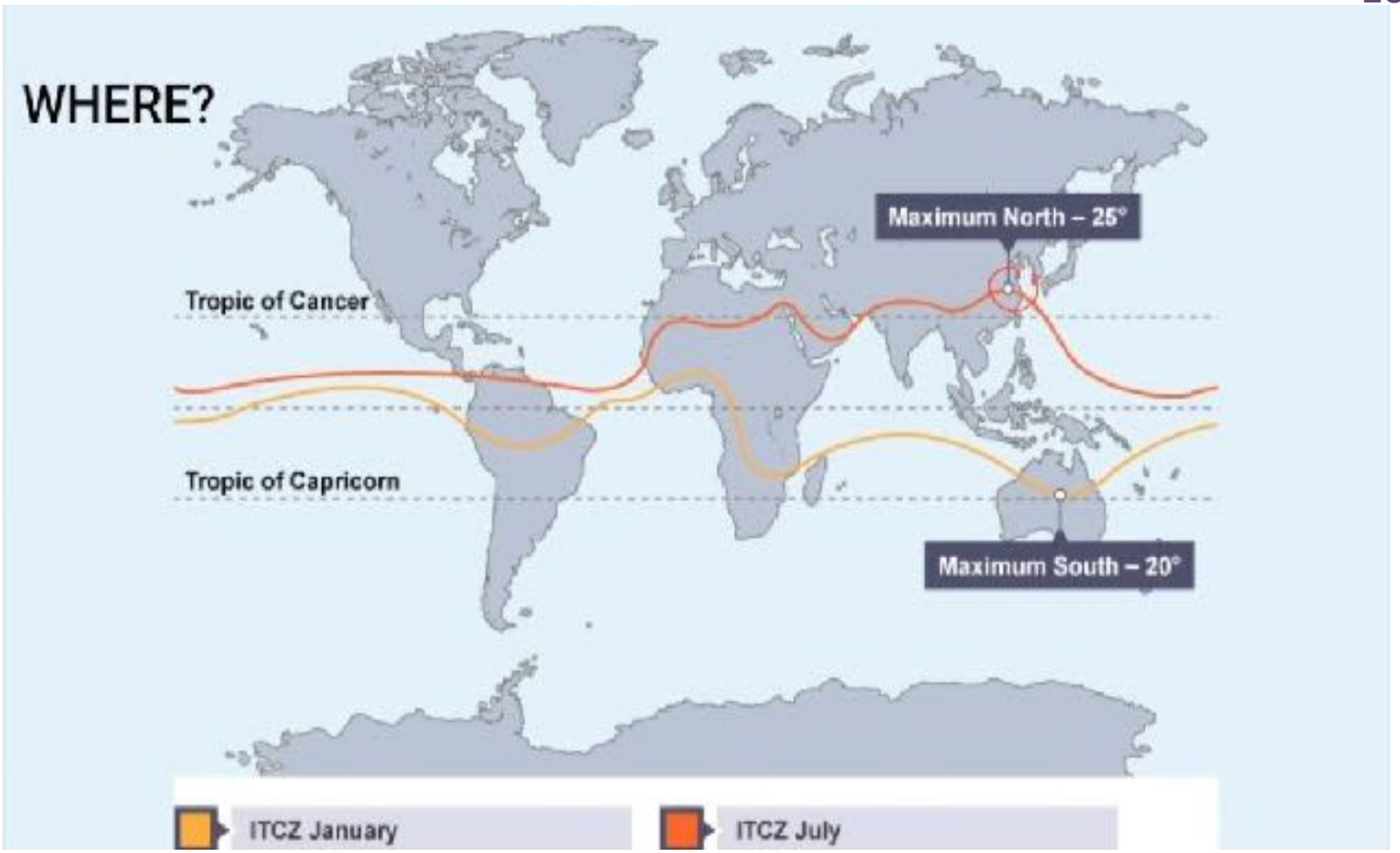
Inter tropical convergence zone also know as Doldrums area of low pressure around equator where trade winds converge.

Convergence of north-east trade winds and south east trade winds due to pressure difference. Trade winds are deflecting towards the west due to **coriolis effect**.

ITCZ is not formed at equator. ITCZ is only formed during equinox at equator. ITCZ has regular rainfall and faces tropical cyclones and floods.

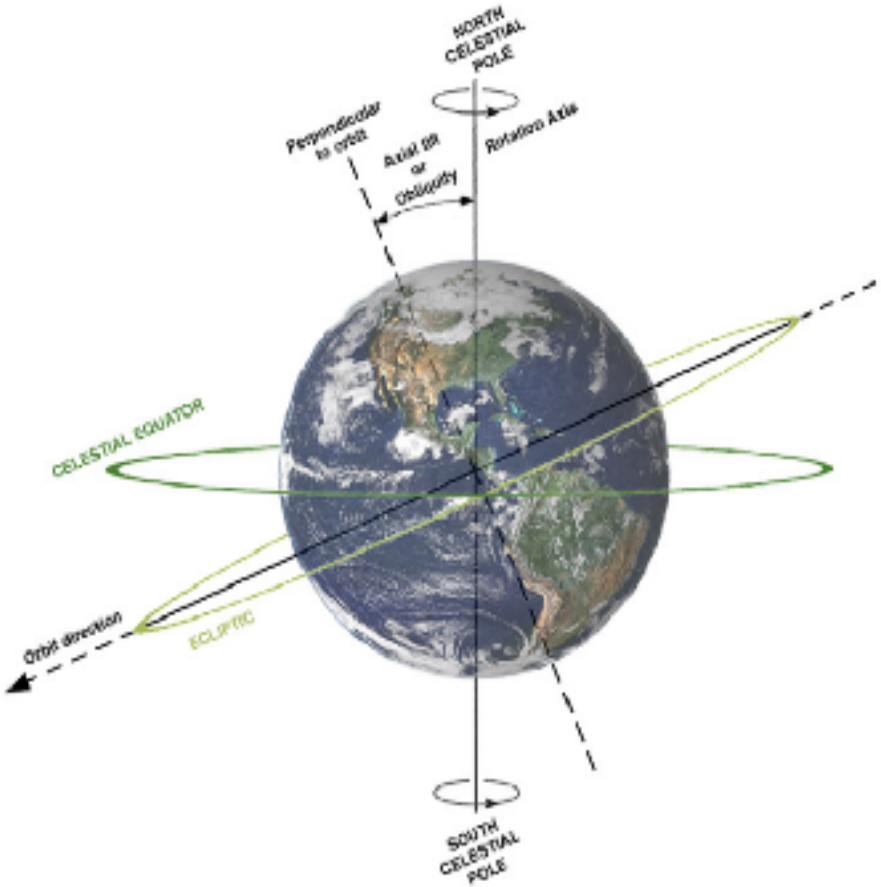
Source- https://www.caleidoscope.in/art-culture/rtp-understanding-culture-indian-states

INTERTROPICAL CONVERGENCE ZONE



Source- https://images.app.goo.gl/dcfKQkaXjJ1JMmGc6

SOLAR GEOMETRY



Dennis Nilsson | CC BY 3.0 (https://creativecommons.org/licenses/by/3.0)|

The Earth's daily rotation about the axis through its two celestial poles (North and South) is perpendicular to the equator, but it is not perpendicular to the plane of the Earth's orbit. In fact, the measure of tilt or obliquity of the Earth's axis to a line perpendicular to the plane of its orbit is currently about 23.5°.

We call the plane parallel to the Earth's celestial equator and through the center of the sun the plane of the Sun. The Earth passes alternately above and below this plane making one complete elliptic cycle every year.

Image - https://images.app.goo.gl/rZWx9uf4WYuW4Ppg9

TIME & POSITION ON EARTH

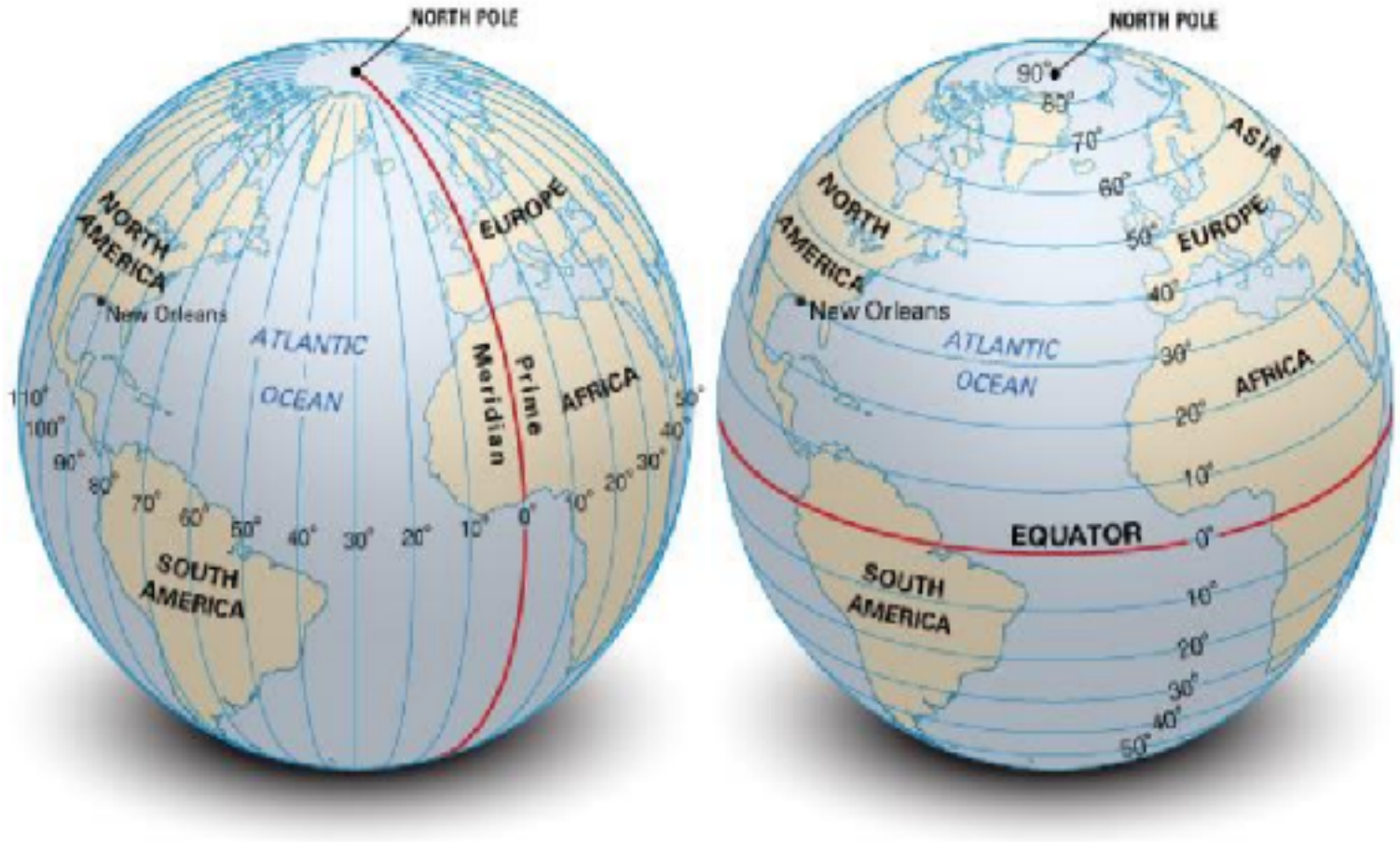
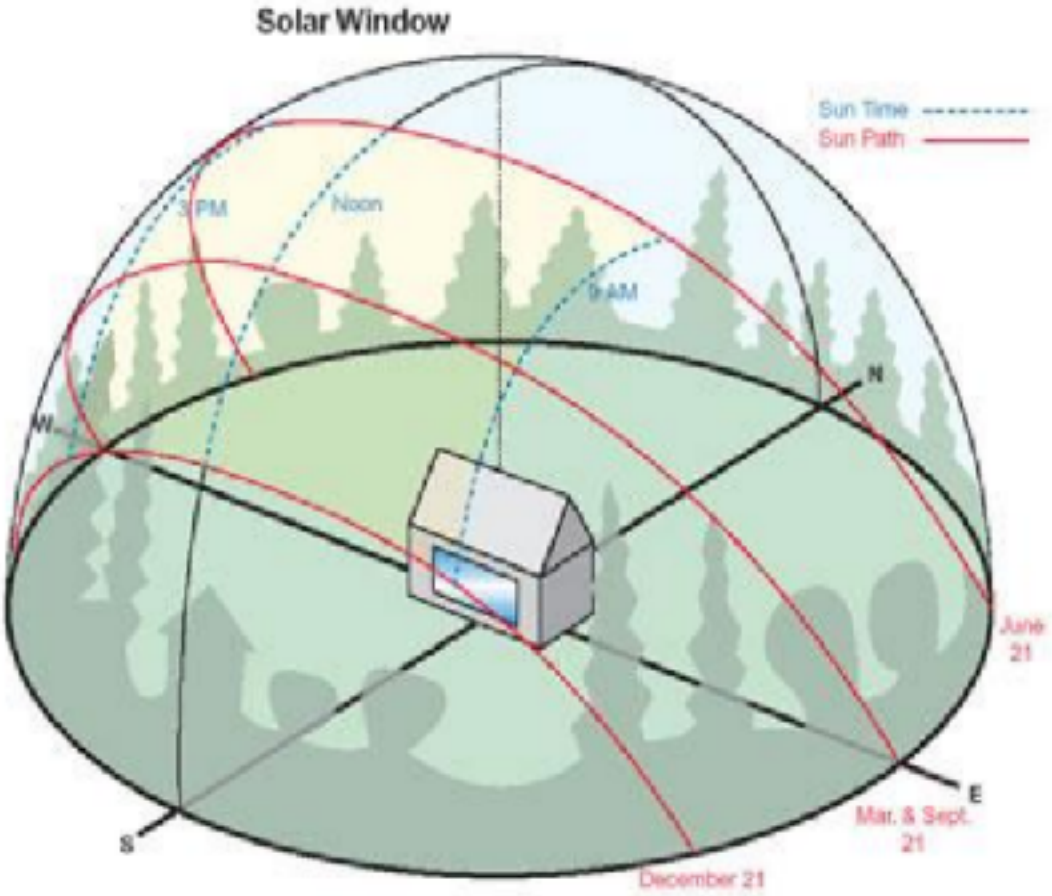


Image - http://teachers.egfi-k12.org/wp-content/uploads/2017/08/Solar-Geometry-presentation.pdf

SOLAR POSIITION – Predicting the location of the sun in the sky



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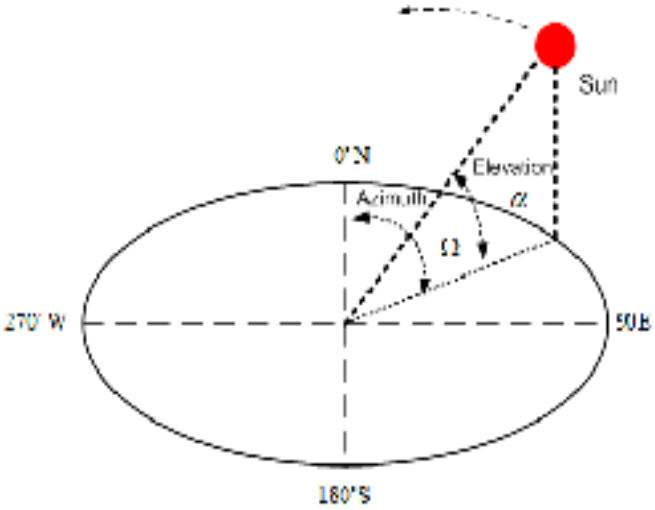
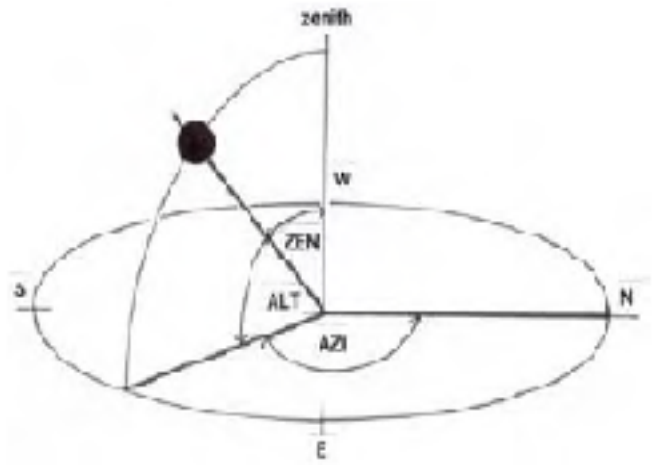
QUANTIFYING SOLAR POSIITION – Lococentric view





In practical work, we consider our point of location on the earth surface as the center of the world: the horizon circle is assumed to be flat and the sky is a hemispherical vault. The sun apparent position in the sky vault can be defined in two basic angles –

Solar Altitude Angle: ALT is the vertical angle of the sun with respect to the horizon (positive above the horizon). It is also known as **elevation** or **profile angle**

Solar Azimuth Angle: AZI is the angle of the sun – measured in the horizontal plane – relative to north. (west of south is positive (+))

Zenith Angle: ZEN is the angle between the sun's direction and the vertical and is the supplementary angle of altitude.

$$ZEN = 90^\circ - ALT$$

Image - http://teachers.egfi-k12.org/wp-content/uploads/2017/08/Solar-Geometry-presentation.pdf

SUN PATH DIAGRAM

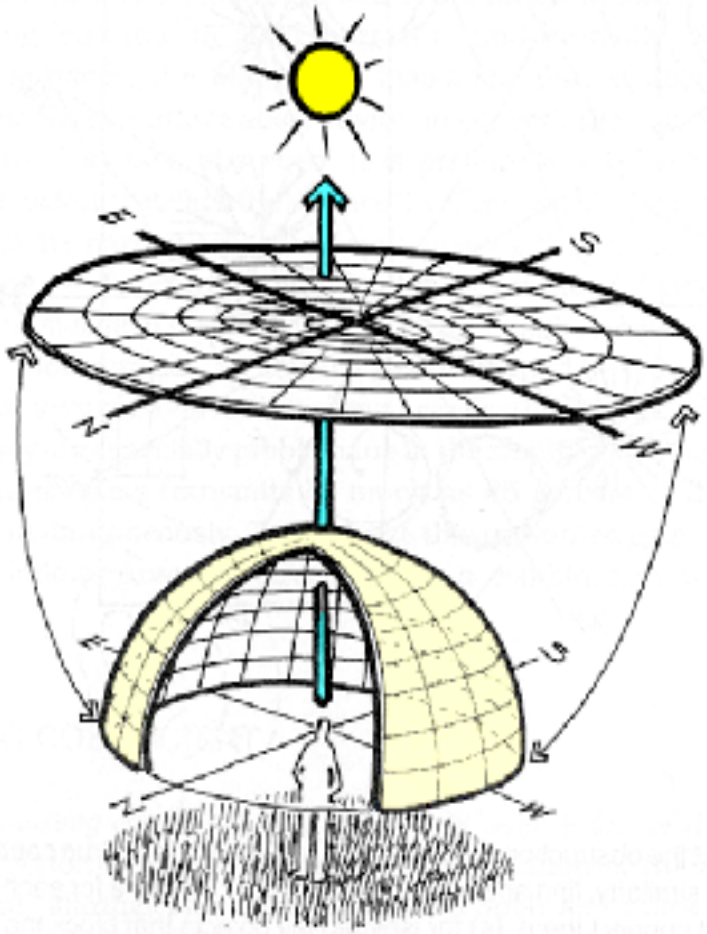


Figure 5.8: Sky dome, with equidistant plan projection showing azimuth and altitude coordinates. *(Reproduced from Moore, 1985, by permission.)*

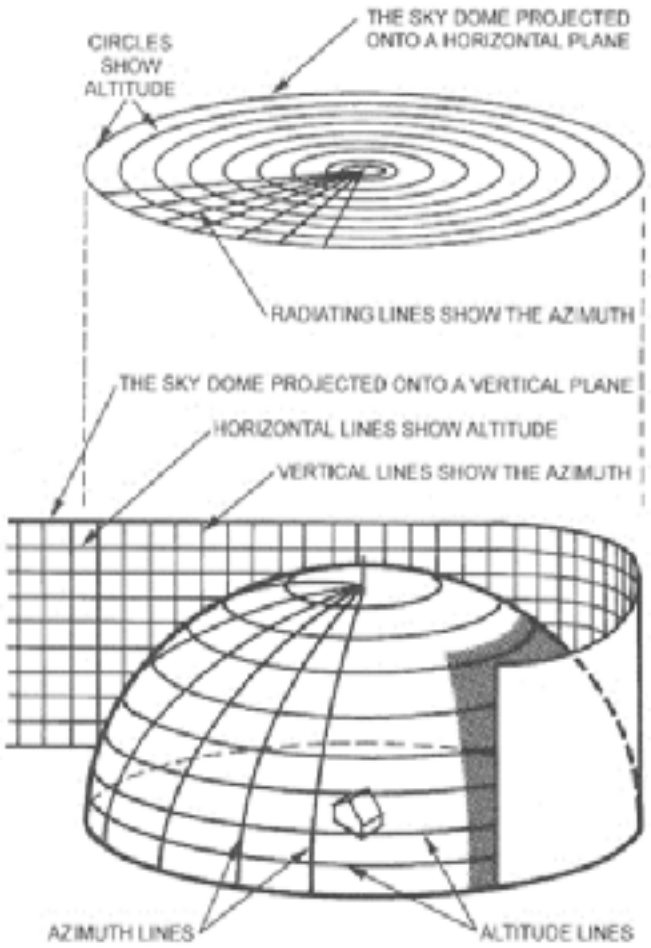


Figure 6.11a Derivation of the horizontal and vertical sun path diagrams.

THERMAL COMFORT

WHY DO WE BUILD?

Buildings are made to house, support and inspire a range of human activities in response to various needs like societal, cultural, economic and political etc.

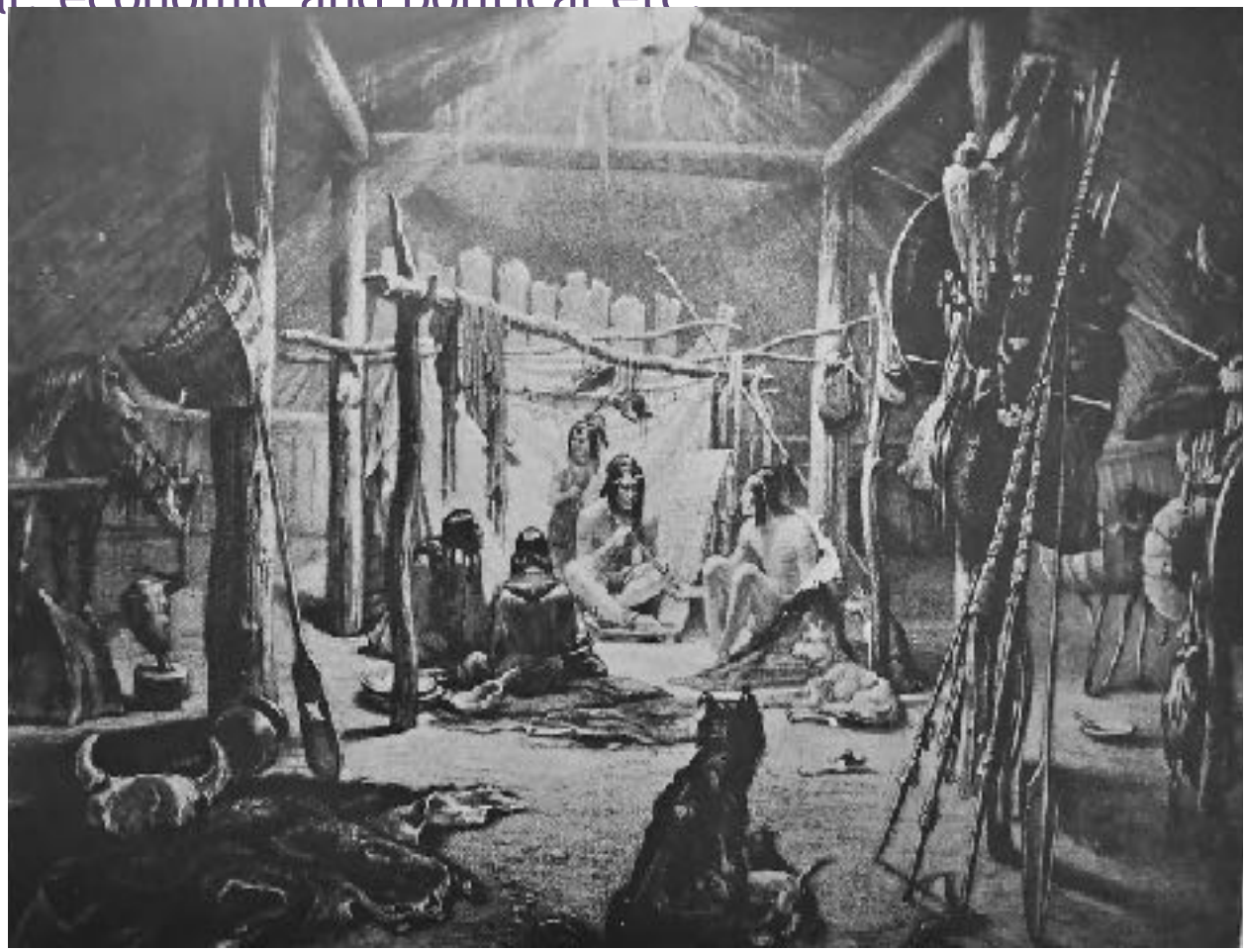


Image – Book – Shelter – Llyod Kahn

According to the international standard EN ISO 7730, thermal comfort is: “that condition of mind which expresses **satisfaction** with the **thermal environment**”.

THERMAL COMFORT is the outcome of a well-balanced combination of **building** systems adapted to both the **location of the building** as well as the type of activity performed within the **building** or the room of the **building.**

Image - https://images.adsttc.com/media/images/5c20/88e4/08a5/e5c8/b900/0a35/slideshow/BuildingScienceHandbook-2016-web(1)-37.jpg?1545636055

PHYSICAL aspect of thermal comfort

The thermal comfort is determined by Environmental factors -

AIR TEMPERATURE - This is the temperature of the air surrounding the body. It is usually given in degrees Celsius (°C).

SURFACE RADIANT TEMPERATURE - Thermal radiation is the heat that radiates from a warm object. Radiant heat may be present if there are heat sources in an environment. Radiant temperature has a greater influence than air temperature on how we lose or gain heat to the environment. Examples of radiant heat sources include: the sun; fire; electric fires; ovens; kiln walls; cookers; dryers; hot surfaces and machinery, molten metals etc.

HUMIDITY - If water is heated and it evaporates to the surrounding environment, the resulting amount of water in the air will provide humidity. Relative humidity is the ratio between the actual amount of water vapour in the air and the maximum amount of water vapour that the air can hold at that air temperature.

AIR VELOCITY - The velocity of the air that a person is in contact with (measured in m/s). The faster the air is moving, the greater the exchange of heat between the person and the air.

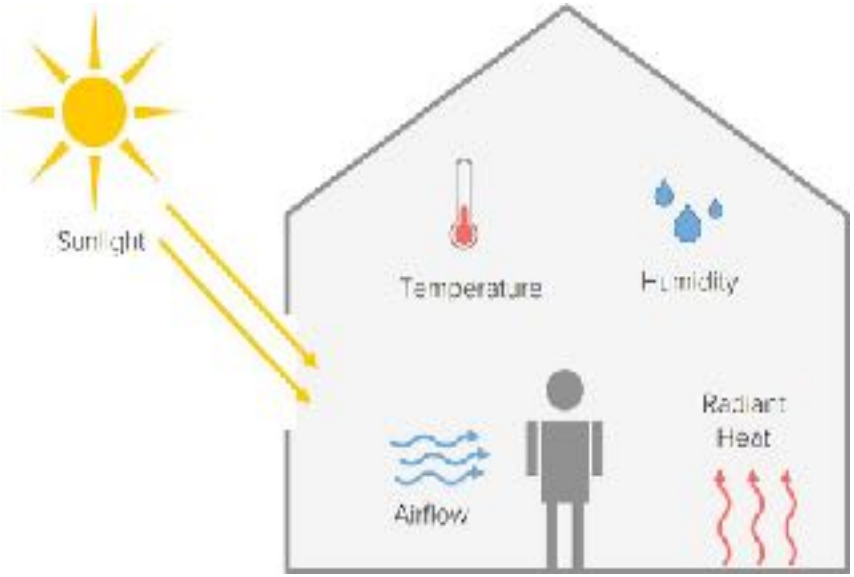


Image - https://ggbec.co.uk/quick-guide-overheating-thermal-comfort

Designing for thermal comfort

There is no 'one size fits all' recipe for thermal comfort

Solutions vary depending on the local climate...

as well as the type of activity performed by the building occupants.

L O C A L

CLIMATE

A C T I V T I Y

PERFORMED

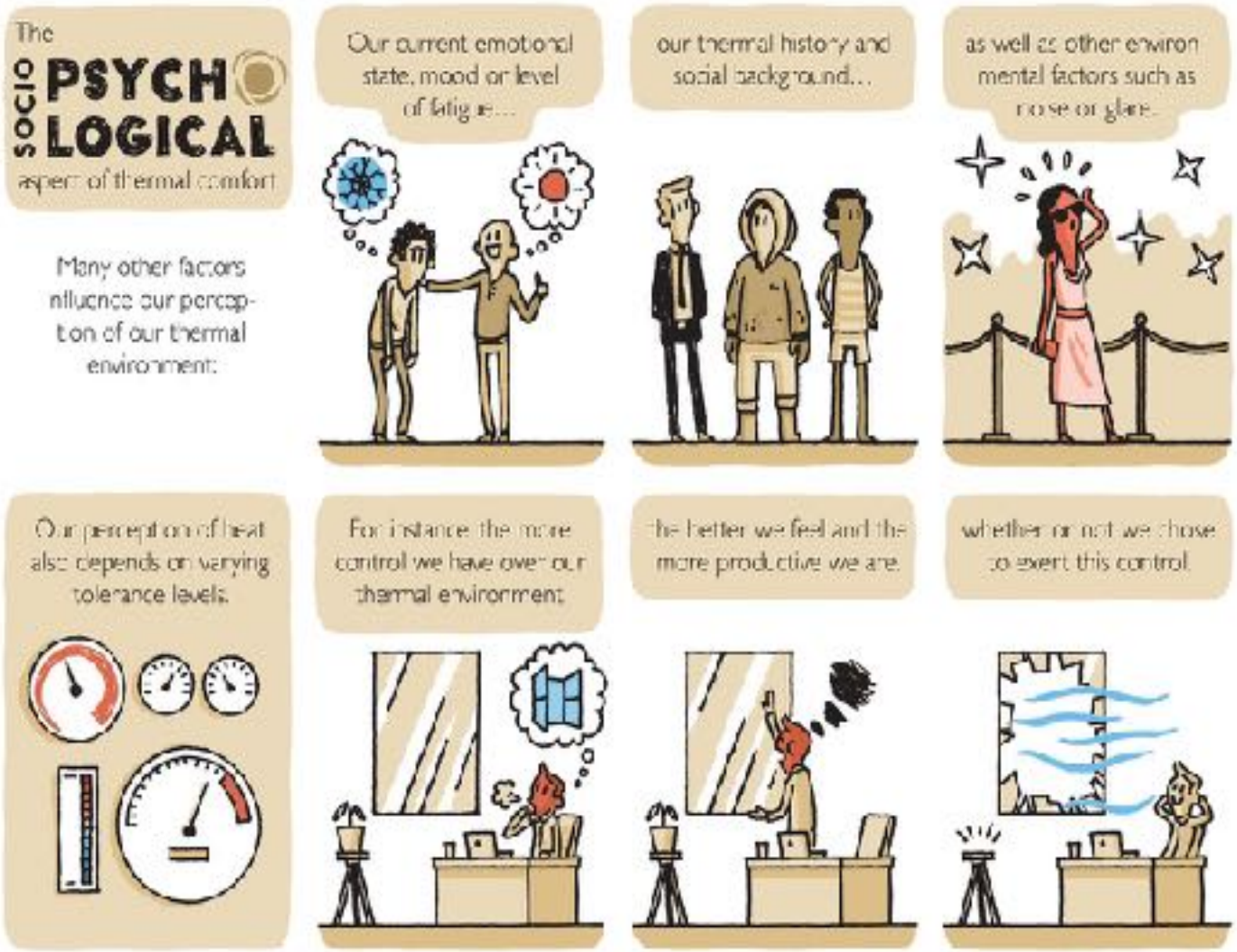
Image - https://images.adsttc.com/media/images/5c20/89df/08a5/e5c8/b900/0a3b/slideshow/MC_Comic_Book_web_HQ-15.jpg?1545636305

THERMAL COMFORT

An individual's current emotional state, mood, level of fatigue, etc. will affect their experience of an environment.

Expectations play an important role in how an individual experiences the physical world: one would expect a beach to be hot and a mountain lodge to be cool, but more generally, perceptions are likely to based on one's own thermal history.

Other environmental factors, noise or glare for example, may influence thermal perception, leading to an increased sensation of overheating.



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