Airport Engineering

Q. Define Aviation (2 marks)

- Aviation is the design, development, production, operation, and use of aircraft.

Q. What are the advantages of air transportation ? (5 marks)

Answer: The Advantages of Air transportation are:

- Improves accessibility to inaccessible areas
- Provides continuous connectivity over land and water (no change of equipment)
- Saves productive time spent on journey
- Increase the demand of specialized technical skill workforce.
- Adds to the foreign reserve through tourism
- Fasatest Speed: Modern jet can travel at 3600 km/h

Advantages of Air transportation…

- Promotion of trade and commerce
- Military use
- Used in Relief and rescue operations
- For Aerial photography
- For Agricultural spraying

Questions

Xm Q. Which of the following is fastest mode of transportation:

(a) Roadways
(b) Waterways
(c) Railways
(d) Airways

Q. Which of the following is fastest mode of transportation:

(a) Roadways
(b) Waterways
(c) Airways
(d) Spaceways

Q. What are the dis-advantages of air transportation? (5 marks)

Answer: The dis-advantages of air transportation are:

- Heavy funds are required, not only initially but also during operation.
- Operations are highly dependent upon weather conditions.
- It needs highly sophisticated machinery
- It creates Noise pollution
- Safety provisions are not adequate
- High energy consumption

History of Air-transportation in Nepal

Q. Discuss about the history of air transportation in Nepal. (5 marks)

Answer: The history of air transportation in Nepal are discussed below:

- **1949:** Formal beginning of aviation in Nepal with the landing of a 4 seated Bonanza aircraft of Indian ambassador Mr. Sarjit Singh at Gauchar.
- **1950**:The first Charter flight By Himalayan Aviation From Goucher to Kolkata.
- **1955**: King Mahendra inaugurated Gauchar Airport and renamed it as Tribhuwan Airport.
- **1957**: Grassy runway transformed into a concrete one.
- **1957**: Department of civil Aviation Founded.
- **1958**: Royal Nepal Airlines Corporation (RNAC) started scheduled service domestically and externally.
- **1960:** Nepal Attained ICAO membership.

History of Air-transportation in Nepal…

- **1964:** Tribhuvan Airport renamed as Tribhuvan International Airport.
- 1967: The 3750 feet long runway extended to 6600 feet.
- 1975: TIA runway extended to 10000 feet from the previous 6600 feet.
- 1976: FIC (Flight information Center) established.
- 1977: Nepal imprinted in the World Aeronautical Chart.
- 1989: Completion of international Terminal Building.
- 1990: New International terminal Building Of TIA inaugurated by king Birendra.

History of Air-transportation in Nepal...

- 1993: National Civil Aviation Policy Promulgated.
- 1995: Domestic terminal Building of TIA and Apron expanded at TIA.
- **2015:** Gautam Buddha International Airport foundation stone laid down by Late Honorable PM Sushil Korala.
- **2016**: Pokhara Regional/Intl' Airport Construction Foundation Stone Laid down by Honorable PM K.P. Sharma Oli.

Classification of Airport

Q. Explain about the classification of Airport as per FAA. (3 marks)
Answer: The classification of Airport as per FAA is discussed below:

- FAA stands for Federal Aviation Administration (Agency)

Based on take-off and landing (FAA)

- Conventional take-off and landing airport (CTOL)
  - The airport having runway length > 1500 m.
- Reduced take-off and landing airport (RTOL)
  - The airport having runway length 1000 to 1500m.
- Short take-off and landing airport (STOL)
  - The airport having runway length 500 to 1000m
- Vertical take-off and landing airport (VTOL)
- The helipad having operational area 25 to 50 sq. m.

Runway Length and Width of some Airports of Nepal

S.N.	Name of Airport	Runway Length(m)	Runway Width (m)
1	Tribhuvan International Airport	3350 m	45 m
2	Pokhara International Airport	2500 m	45 m
3	Gautam Buddha (Lumbini) International Airport	3000 m	45 m
4	Nijgadh International Airport	3600 m	60 m
5	Nepalgunj Domestic Airport	1504 m	30 m
6	Biratnagar Domestic Airport	1505 m	30 m
7	Lukla Domestic Airport	527 m	30 m

Classification of Airport…

Q. Explain about the classification of airport based on ICAO. (5 marks)

Answer: The classification of airport based on ICAO is described as:

- ICAO stands for International Civil Aviation Organization.

Based on the Geometric design (ICAO)

- It employs aerodrome reference code, it consists of length of runway available
- Classified using **code number 1 to 4 (First four numeral digit)**
  - Based on Airport reference field length.
- Classified using **code letters A to F (First six English Capital Letter)**
  - Based on wing span and outer main gear wheel span

Table 1.1. Airport Reference Code

Table 1-1. Aerodrome reference code
(see 1.4.2 to 1.4.4)

Code element 1		Code element 2		
Code number (1)	Aeroplane reference field length (2)	Code letter (3)	Wing span (4)	Outer main gear wheel span[a] (5)
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1 200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1 200 m up to but not including 1 800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1 800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m

a. Distance between the outside edges of the main gear wheels.

International airports will generally be Code number 3 or 4.

Students need to be aware of the Aerodrome Reference Code. ICAO standards reference the code number for slightly different requirements based on the length of the runway.

Classification of Airport…

Classification of Airport Based on function:

- Domestic airports
- International airports
- Combination of international and domestic
- Military aviation airports

Based on runway Length

Airport Type	Basic Runway Length (m)		Width of Runway Pavement	Maximum Longitudinal Gradient (%)	Maximum Effective Gradient (%)
	Maximum (m)	Minimum (m)			
A	>2100 m	2100 m	45 m	1.50%	1%
B	2099 m	1500 m	45 m	1.50%	1%
C	1499 m	900 m	30 m	1.50%	1%
D	899 m	750 m	22.5 m	2%	2%
E	749 m	600 m	18 m	2%	2%

Q. The maximum longitudinal gradient of runway should not be greater than:

(a) 0.5 % (b) 1 % (c) 1.5 % (d) 2 %

The maximum effective gradient of runway should not be greater than:

(a) 0.5 % (b) 1 % (c) 1.5 % (d) 2 %

Extra Informations of Airports of Nepal

- **Total number of International Airport in Nepal = 2 (TIA and Gautam Buddha International Airport)**
- Total number of constructed airport in Nepal = 55
- **Total number of airport operation in Nepal** = 43
- **Highest Airport of Nepal** = Syangboche Airport (3780m above msl)
- Lowest Airport in Nepal = Biratnagar Airport (72 m above msl)
- Dangerous airport of Nepal = Lukla Airport (Tenzing Hillary Airport)
- **Highest number of Airport having district in Nepal =** Solukhumbhu (5 numbers)

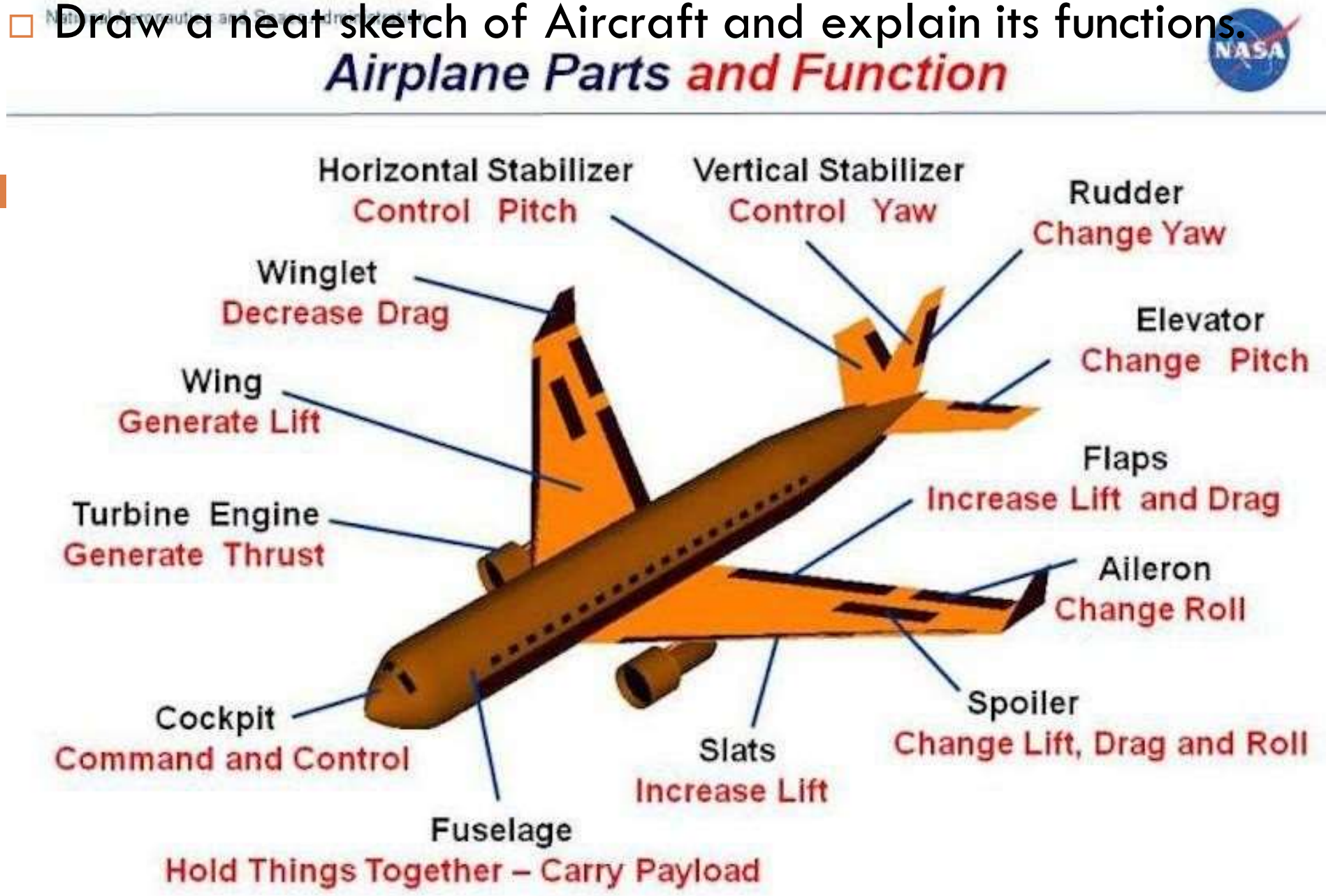
Information of Tribhuwan International Airport:

- Location = Kathmandu
- **Length of Runway = 3350 meter** (10990 feet)
- Width of runway = 151 feet (46m) ≈150 feet (45 m)
- **Runway System = One-way**
- Altitude = 1339 m amsl (4392 feet)
- **Runway numbering (North & South) = 20 & 02**
- Runway bearing (North & South) = 20° & 200°

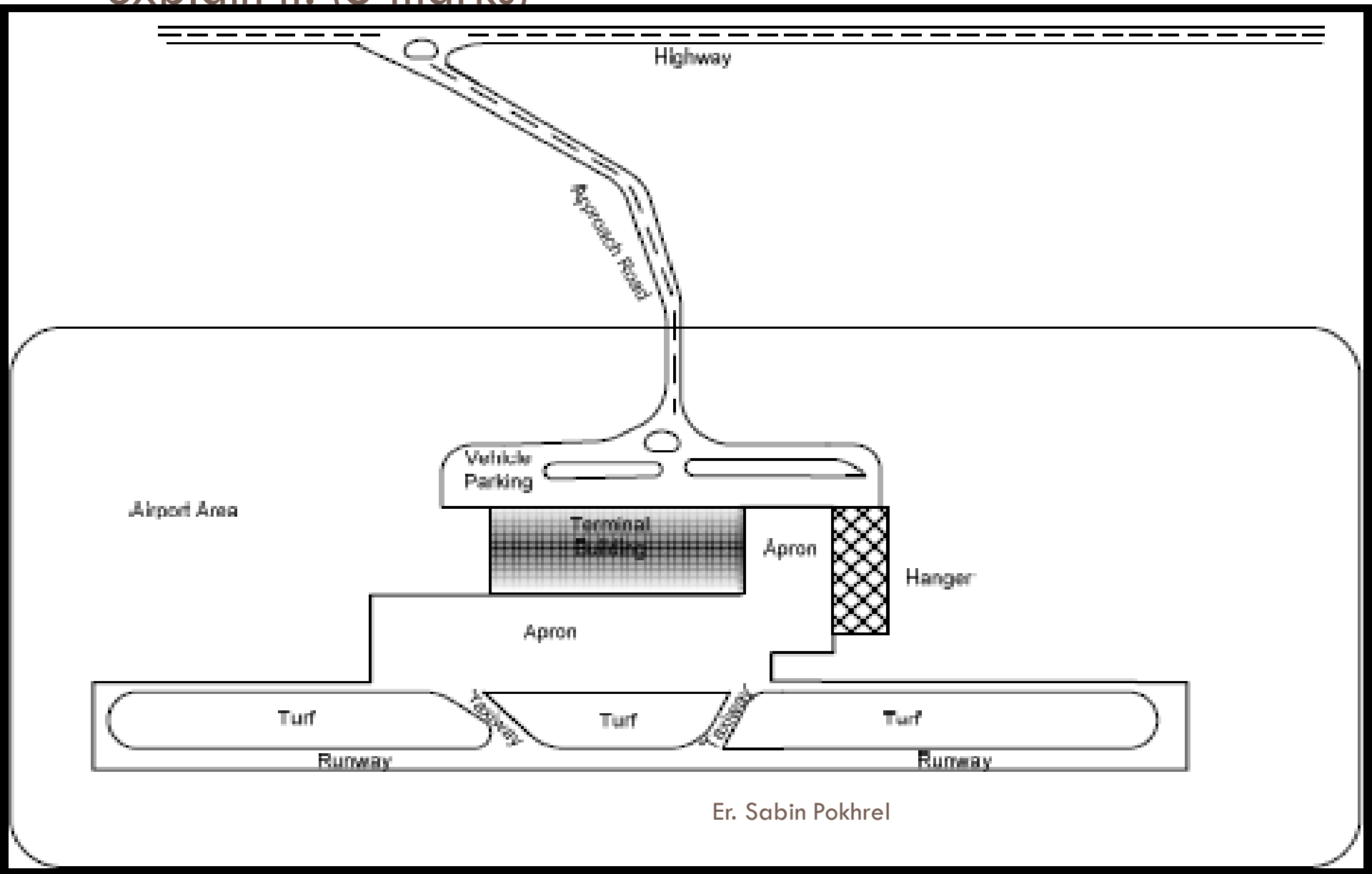
Information of Tribhuwan International Airport…

- One-way Capacity = 905 passengers/hour with 21 hours of operation
- **Surface runway strength = 54 F/A/W/T**
- Glider path angle = 2.5°
- Reference Temperature = 27.8 °C
- Apron Capacity International = 9 medium and wide body Aircraft
- Apron Capacity Domestic = 17 small aircrafts
- Helipad = 13 Helicopters

- Draw a neat sketch of Aircraft and explain its functions.



Draw a neat sketch of Typical Layout of Airport and explain it. (5 marks)



(I) **Apron:**

- The Airport Apron is the area of an Airport where Aircrafts are parked, unloaded or loaded, refueled, etc.
- Aprons are also sometimes called ramps.

(II) **Hanger:**

- A hanger is a closed building structure to hold aircrafts, space-crafts in protective structure.
- **Maintenance activities are done in Hanger.**

Some Terminology…

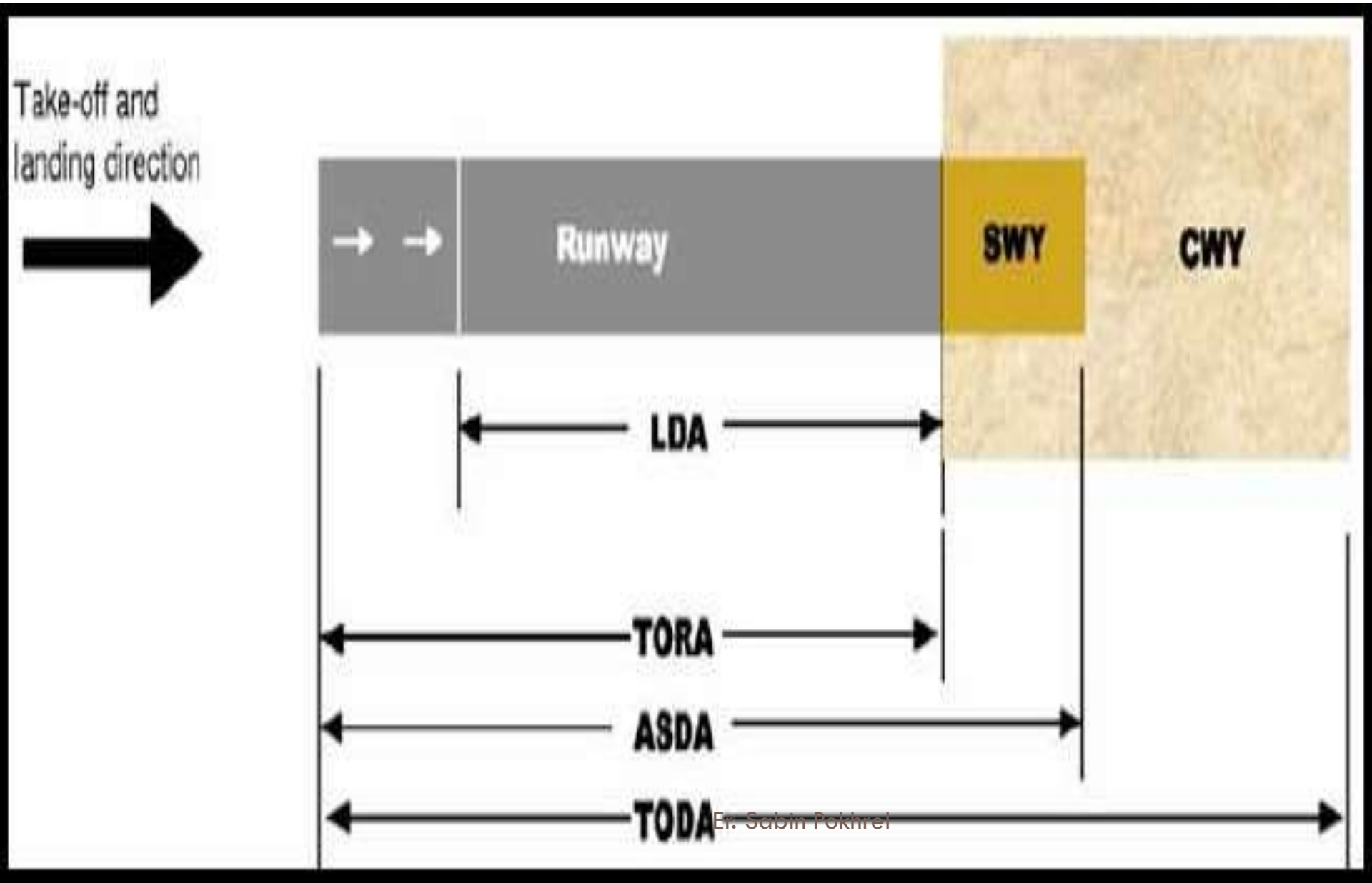
(III) **Taxiway:**

- A taxiway is a path for aircraft at an airport connecting runways with Aprons, Hangers, terminals and other facilities.

(IV) Turf:

- The upper layer of ground that is made up of grass.

Draw a neat sketch of Declared Distances of Runway and explain briefly. (5 marks)



Declared distances…

(1) **Take-off run available (TORA)**: the length of runway declared available and suitable for the ground run off an aero plane taking off.

(2) **Take off distance available (TODA):** the length of takeoff run available plus the length of the clearway, if provided.

(3) **Accelerate stop distance available (ASDA):** the length of the take-off run available plus the length of the stopway, if provided.

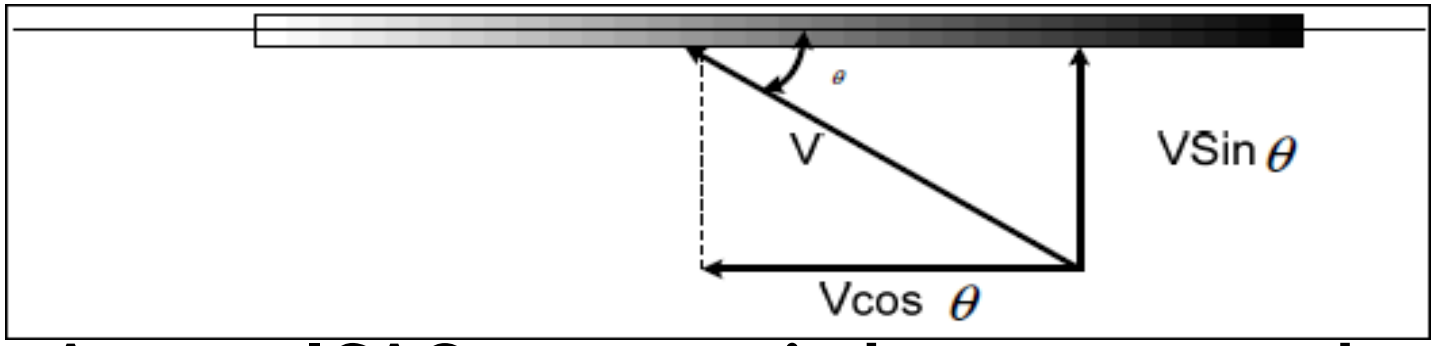
(4) **Landing distance available (LDA):** the length of runway which is declared available and suitable for ground run of an aeroplane landing

Wind

Q. Define Head wind (2 marks)

- Direction of wind opposite to the direction of landing is known as Head wind.

(2) **Cross wind Component:**



- **<u>As per ICAO, cross wind component should not exceed 35 kmph.</u>**

Wind Coverage

Q. Define wind coverage (3 marks)

- The percentage of time in year during which the Cross Wind Component (CWC) remains within the limit is called wind coverage.
- FAA standards for mixed air traffic wind coverage should be 95% within the limit of 25 kmph CWC.
- For busy airport, Wind Coverage may be (98-100)%

Wind Rose method

Q. Define Wind rose. (2 marks)

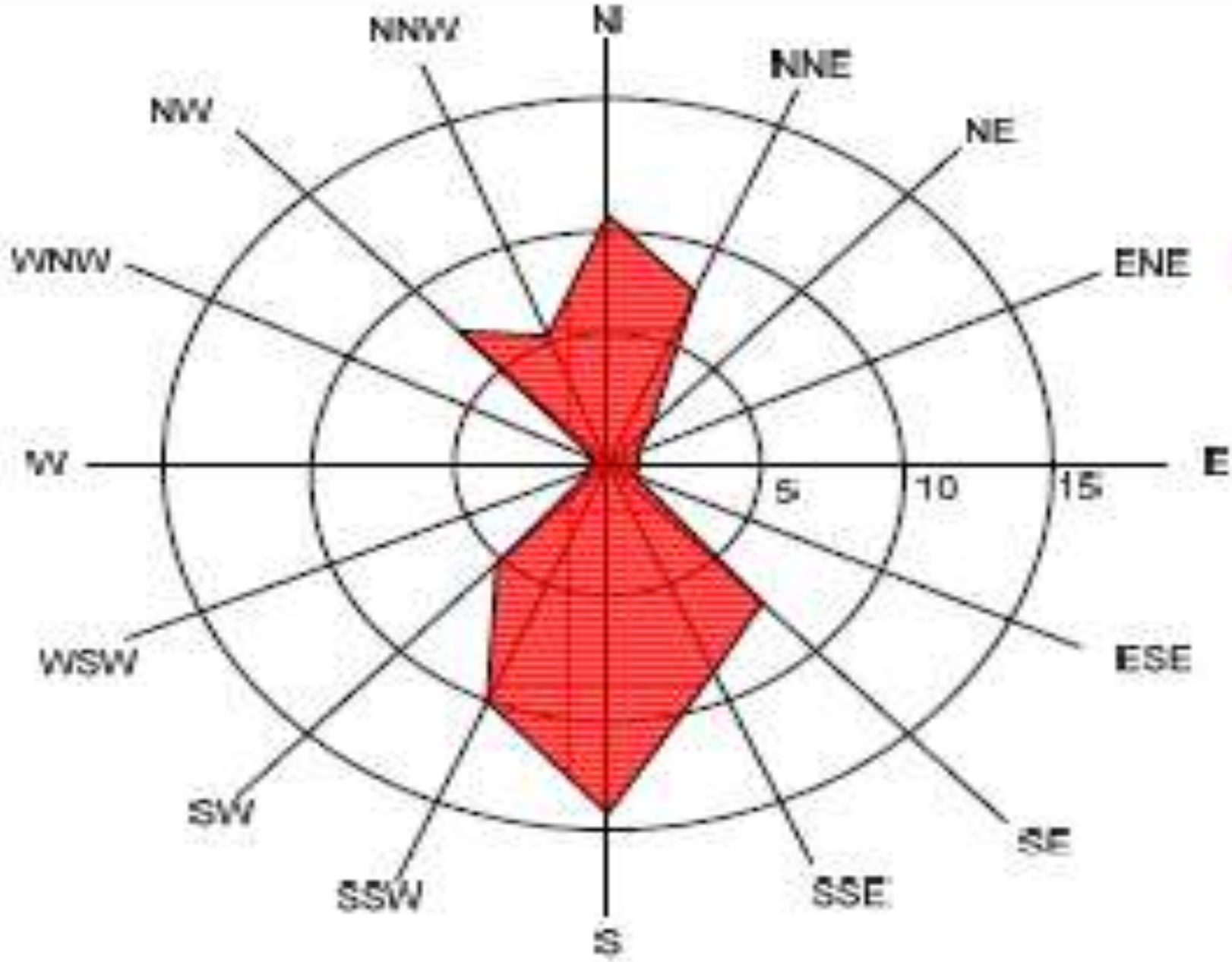
- Typically **wind rose is applied for the orientation of runway.**
- It is the graphical representation of wind data: direction and intensity.
- Data should be collected for the period of 5 to 10 years.
- Wind data average of 8 years period is taken.

Numerical:

- Draw a wind rose diagram from the following data and compute the calm period also. (10 marks)

Wind direction	Duration, %			Total in each direction, %
	6.4 -25 kmph	25 – 40 kmph	40 – 60 kmph	
N	7.4	2.7	0.2	10.3
NNE	5.7	2.1	0.3	8,1
NE	2.4	0.9	0.6	3.9
ENE	1.2	0.4	0.2	1.8
E	0.8	0.2	0.0	1.0
ESE	0.3	0.1	0.0	0.4
SE	4.3	2.8	0.0	7.1
SSE	5.5	3.2	0.0	8.7
S	9.7	4.6	0.0	14.3
SSW	6.3	3.2	0.5	10.0
SW	3.6	1.8	0.3	5.7
WSW	1.0	0.5	0.1	1.6
W	0.4	0.1	0.0	0.5
WNW	0.2	0.1	0.0	0.3
NW	5.3	1.9	0.0	7.2
NNW	4.0	1.3	0.3	5.6

Total % = 86.5



Wind Rose

Numericals…

Therefore, runway direction is in N-S direction.

(100 - 86.5) = 13.5 % of time wind intensity is less than 6.4 kmph. This period is called **Calm Period.**

Basic length of runway characteristics

Q. What are the basic length of runway characteristics? (3 marks)

- It is the length of runway under the following conditions:
  - Airport altitude is at sea level
  - **Airport temperature is 15 ^{0} Celsius**
  - Runway level in longitudinal direction
  - No wind is blowing on runway
  - Aircraft is loaded to its full capacity.

Airport Reference Temperature (ART)

$$t_r = t_a + \frac{tm - ta}{3}$$

Where,
tr = airport reference temperature
ta = Average daily temperature for the hottest month of the year
tm = maximum daily temperature for the same month of the year..

Q. If average daily temperature for the hottest month of the year is 30 degree celcius and maximum daily temperature for the same month of the year is 39 degree celcius then what is the value of airport reference temperature ?

(a) 30° C
(b) 33° C
(c) 36° C
(d) 39° C

$$Tr = 30 + (39-30)/3$$

$$= 33 \text{ degree celcius}$$

Numericals

Q. The monthly mean temperature of the atmosphere at a particular site, where an airport has to be developed are given below. Determine the airport reference temperature. (5 marks)

Months		Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Temperature °C	Mean of Average Daily	3	15	20	25	35	40	32	30	27	22	12	16
	Mean of Maximum Daily	5	17	23	32	43	50	37	35	31	28	18	19

Numericals…

Solution:

- Here the hottest month is June.
- Mean of average daily temperature (ta) = 40 degree celcius
- Mean of maximum daily temperature (tm) = 50 degree celcius

$$t_r = t_a + \frac{tm - ta}{3}$$

$$= 40 + \left(\frac{50-40}{3}\right)$$

$$= 43.33 \text{ degree Celsius}$$

Runway Length Correction

Q. Explain in detail about the runway length correction as per ICAO and FAA.

- Basic length of runway is for mean sea level having standard atmospheric conditions.
- It is necessary to carry out corrections for elevation, temperature and gradient.

Step I:

- From aeroplane reference manual, select a basic runway length (L) required for take off or landing at standard atmospheric conditions (sea level, zero wind, zero runway slope and temperature 15 degree Celsius)

Runway Length Correction…

Step II: Correction for elevation (h)

- The basic length selected for the runway should be increased at the rate of **7 % per 300** meter elevation above mean sea level.
- The elevation correction factor

$$L(h) = F(h) * L$$

Where,

$$F(h) = [(0.07 * \frac{h}{300}) + 1]$$

h = elevation (m)

Runway Length Correction…

Step III: Correction for temperature (t)

- The runway length corrected for the elevation should be further increased at the rate of **1 % for every 1 degree celsius rise in temperature.**
- The temperature gradient of the standard atmospheric from the mean sea level to the altitude at which temperature becomes 15 degree celsius is -0.0065 degree Celsius per meter
- The elevation and temperature correction factor,
- $L(h,t) = L(h) * F(t)$

Where,

Temp. correction factor $F(t) = 0.01\ [\ t - (15-0.0065*h)] + 1$

Runway Length Correction…

t = aerodrome reference temperature (monthly mean of daily maximum temperature at the hottest month of the year) in degree Celsius

- Check for total correction for elevation and temperature:
- If the total correction (elevation and temperature) **exceeds 35 %** of the basic runway length, these correction should then be checked up by conducting specific studies.

Runway Length Correction…

Step IV: Correction for runway slope (g):

- The runway length corrected for elevation and temperature should be further increased at the rate of **20 % for each 1 % of the runway slope. (effective gradient)**
- Total correction factor L (h,t&g) = L (h,t) * F(g)

Where,

Slope correction factor, F(g) = [(0.20 *g) +1]

g = runway longitudinal slope

Numerical

Q. The runway length required for landing and takeoff under standard conditions are 3000 m and 2500 m respectively. The airport is situated at the elevation of 150 m elevation and variation of temperature for each month is given in table below. The effective runway gradient is 0.5%. Determine the corrected length after correction recommended by ICAO and FAA. (10 marks)

Months		Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Temperature °C	Mean of Average Daily	3	15	20	25	35	40	32	30	27	22	12	16
	Mean of Maximum Daily	5	17	23	32	43	50	37	35	31	28	18	19

Numericals…

- Runway length for landing at standard atmospheric condition = 3000 m
- Runway length for takeoff at standard atmospheric condition = 2500 m
- Runway Gradient (g) = 0.5 %
- Aerodrome elevation (h) = 150 meter

From table,

- Mean of average daily temperature (ta) = 40 degree celcius
- Mean of maximum daily temperature (tm) = 50 degree celcius

Numericals…

- Airport reference temperature $t_r = t_a + \frac{tm - ta}{3}$

$= 40 + (\frac{50-40}{3})$

$= 43.33$ degree Celsius

(I) Correction for elevation (h)

$$L(h) = F(h) * L$$

$$F(h) = [(0.07 * \frac{h}{300}) + 1]$$

$$= [(0.07 * \frac{150}{300}) + 1] * 3000$$

$= 3105$ meter

Numericals…

(II) Correction for temperature(t), L(h,t) = L(h) * F (t)

F(t) = {0.01 [t – (15-0.0065*h)] }+1

L(h,t) = 3105 * 0.01 [43.33 – (15-0.0065*150)] +1]

= 4015 meter

- Check for total correction for elevation and temperature

$$= \left(\frac{4015-3105}{3105}\right)*100\ \%$$

$$= 29.31\ \% < 35\ \%\ \text{ok}$$

Numericals…

(III) Correction for runway slope (g)

$L(h,t\&g) = L(h,t) * F(g)$

$= 4015 * [(0.2 * g) + 1]$

$= 4015 * [(0.2 * 0.5) + 1]$

$= 4417$ meter

Therefore , required corrected length of runway is 4417 meter.

Q. Standard length of runway of an airport is 3000 m and actual RL is 600 . Find the design length of runway:

(a) 3210
(b) 3420
(c) 3630
(d) 3840

Various facilities to be provided in airport terminal building:

Q. What are the various facilities to be provided in airport terminal building? (5 marks)

Answer: The various facilities to be provided in airport terminal building are:

- Passenger and baggage handling counter
- Baggage claim section
- Enquire counter
- Space for handling & processing mail, cargo etc.
- Public Telephone booth
- Waiting hall for passenger & visitors
- Separate toilet facilities for male and female
- Restaurants & Bars for fooding

Various facilities to be provided in airport terminal building…

- First aid room
- General store & gift store
- Space for newspapers
- Space for airport staff
- Weather bureau
- Post office
- Bank
- Security & Police
- Passport control
- Airline office

ICAO

- ICAO stands for **International Civil Aviation Organization.**
- ICAO is a UN specialized agency, **established in 1944 A.D. (1947 A.D.)**
- ICAO works with 191 member states
- ICAO Annex-14 contains the standards and recommended practices (specifications).

Annex 14 Volume I = Aerodrome Design and Operations

Annex 14 Volume II = Heliports

- The **Headquarter of ICAO is at Montreal, Canada.**
- **Nepal received the ICAO membership in 1960 AD**

CAAN

- CAAN stands for **Civil Aviation Authority of Nepal**.
- CAAN was established on **31st December,1998 A.D.** under Civil Aviation Act,1996 A.D.
- CAAN is located at Babarmahal, Kathmandu

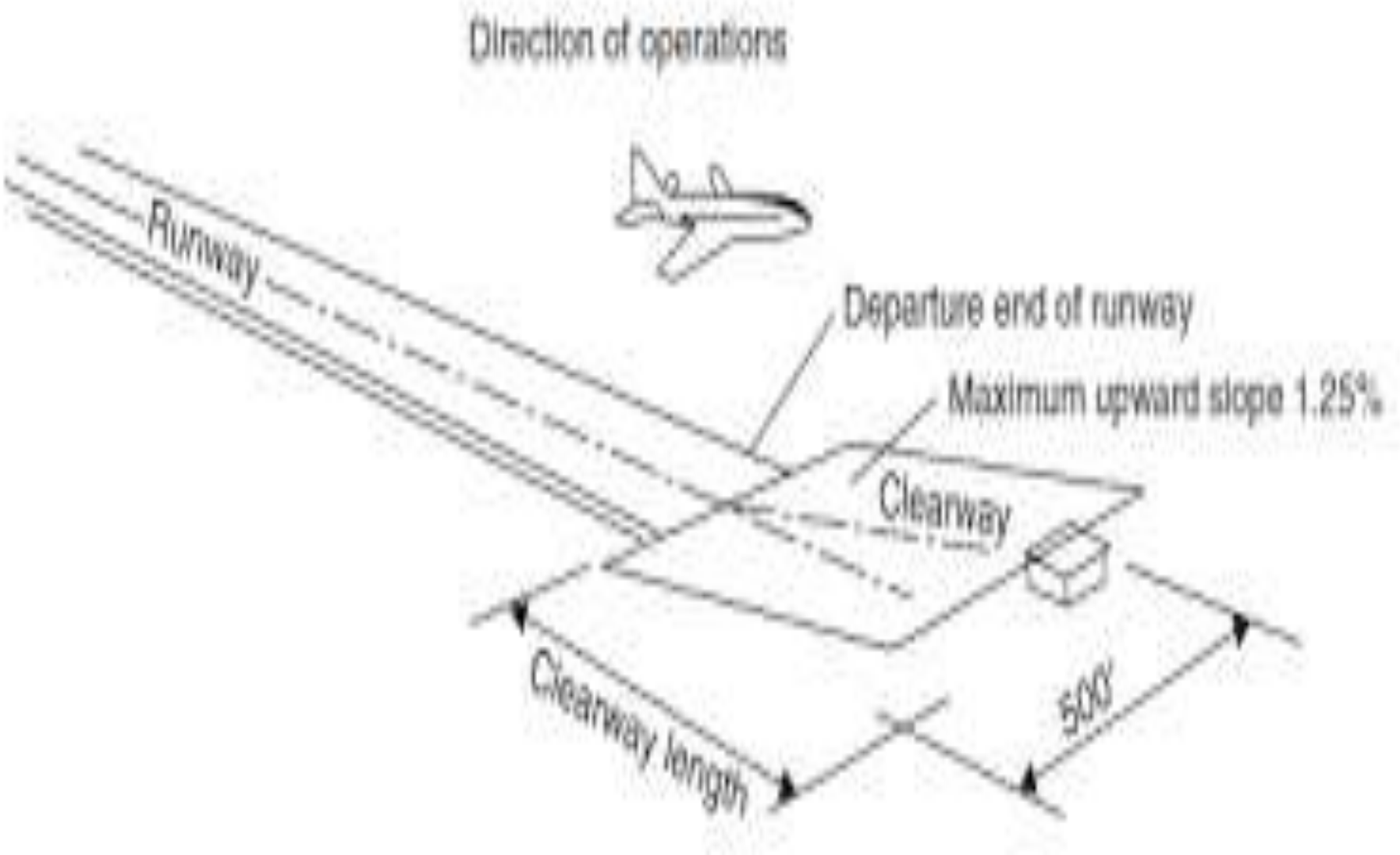
Design Criteria for Runway as per ICAO:

(I) Longitudinal and Effective Gradient

- In general, **minimum gradient should not be less than 0.5 %**

Types of Airport	Maximum Effective Gradient (%)	Maximum Longitudinal Gradient (%)
A,B & C	1%	1.50%
D & E	2%	2%

Longitudinal Gradient



Design Criteria for Runway as per ICAO…

(II) Safety Area

- The runway safety is an area which is cleared, drained and graded.
- As per ICAO, the minimum width of safety area should be as follows:

Types of Runway	Types of Airport	Width of Safety Area
For Instrumental Runway	A,B,C,D,E	300 meter
For Non-Instrumental Runway	A,B,C	150 meter
	D,E	78 meter

Safety Area

Design Criteria for Runway as per ICAO…

(III) Transverse Gradient

- The transverse gradient should not be less than 0.5 % for satisfactory drainage.
- It is provided for quick disposal of surface water.
- Maximum transverse gradient:
  - 1.5 % (For A,B & C types of Airport)
  - 2 % (For D & E types of Airport)

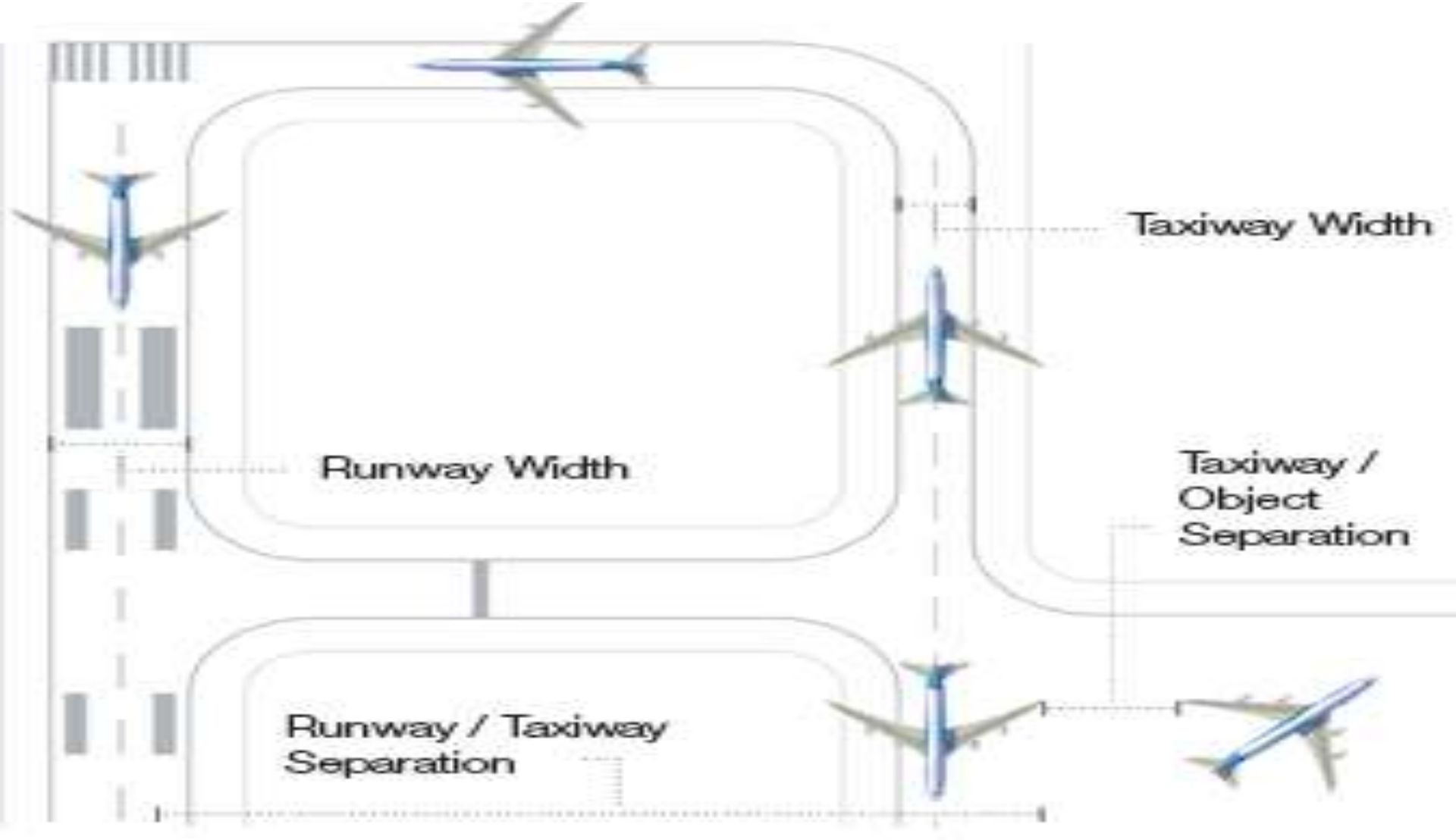
Design Criteria for Runway as per ICAO…

(IV) Width of taxiway:

- Width of taxiway varies from 7.5 meter to 22.5 meter.

Types of Airport	Minimum Width (m)
A	22.5 m
B	22.5 m
C	15 m
D	9.9 m
E	7.5 m

Taxiway Width



Design Criteria for Runway as per ICAO…

(V) Transverse Gradient of Shoulder:

- Maximum gradient = 2.5% (Within a distance of 75 m from the centre line of runway)
- Maximum gradient = 5 % (Beyond the shoulder)

(VI) Marking of Airport:

(a) **Apron Marking = Yellow Color**

(b) Shoulder Marking= Yellow (Width of 90 cm)

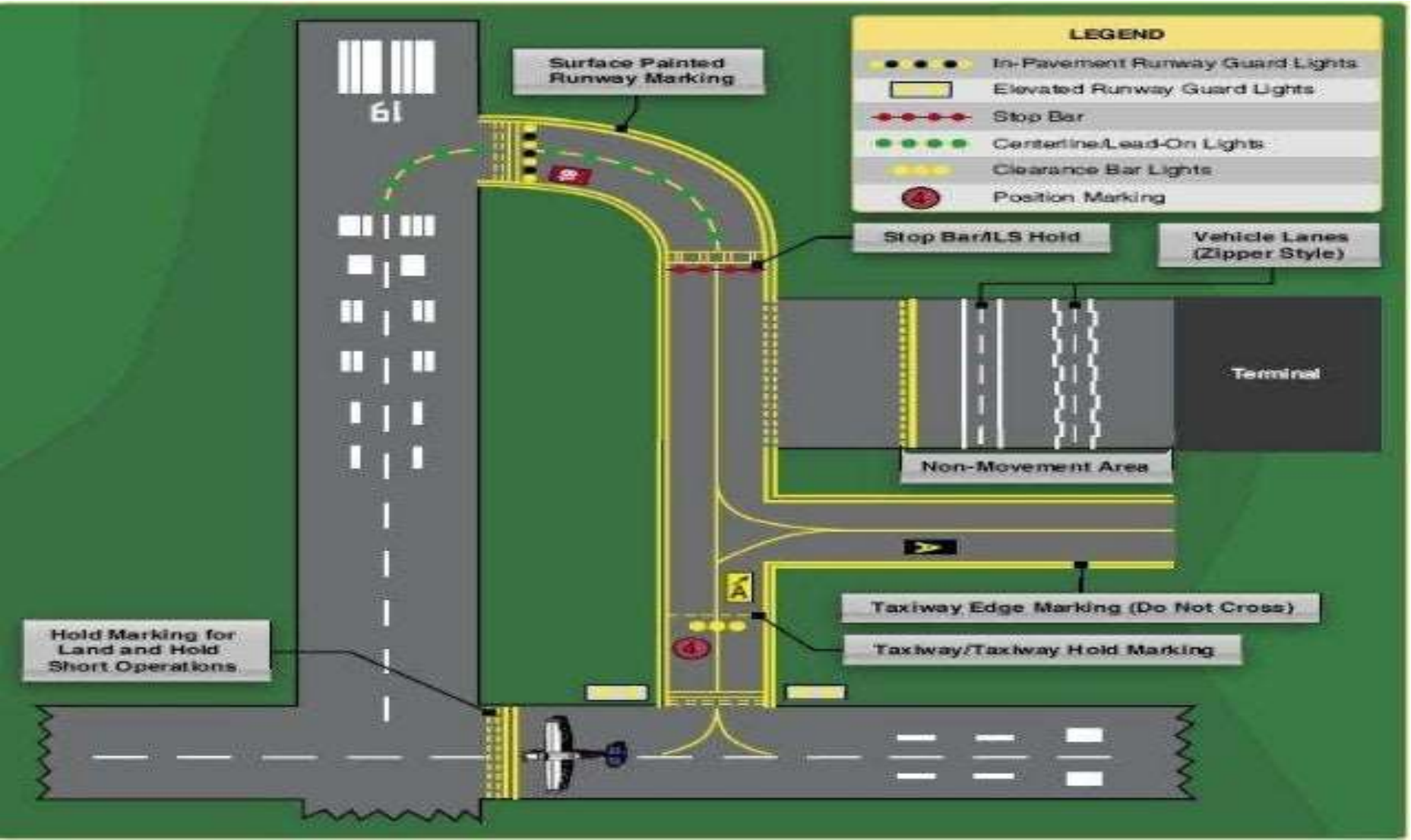
(c) Taxiway Marking = Yellow (Width of 15 cm)

Design Criteria for Runway as per ICAO…

(d) **Runway Marking = White Colour**

- ✓ Centre-line = 90 cm wide broken strip line
- ✓ Side Strip = 90 cm wide solid line

Runway Marking

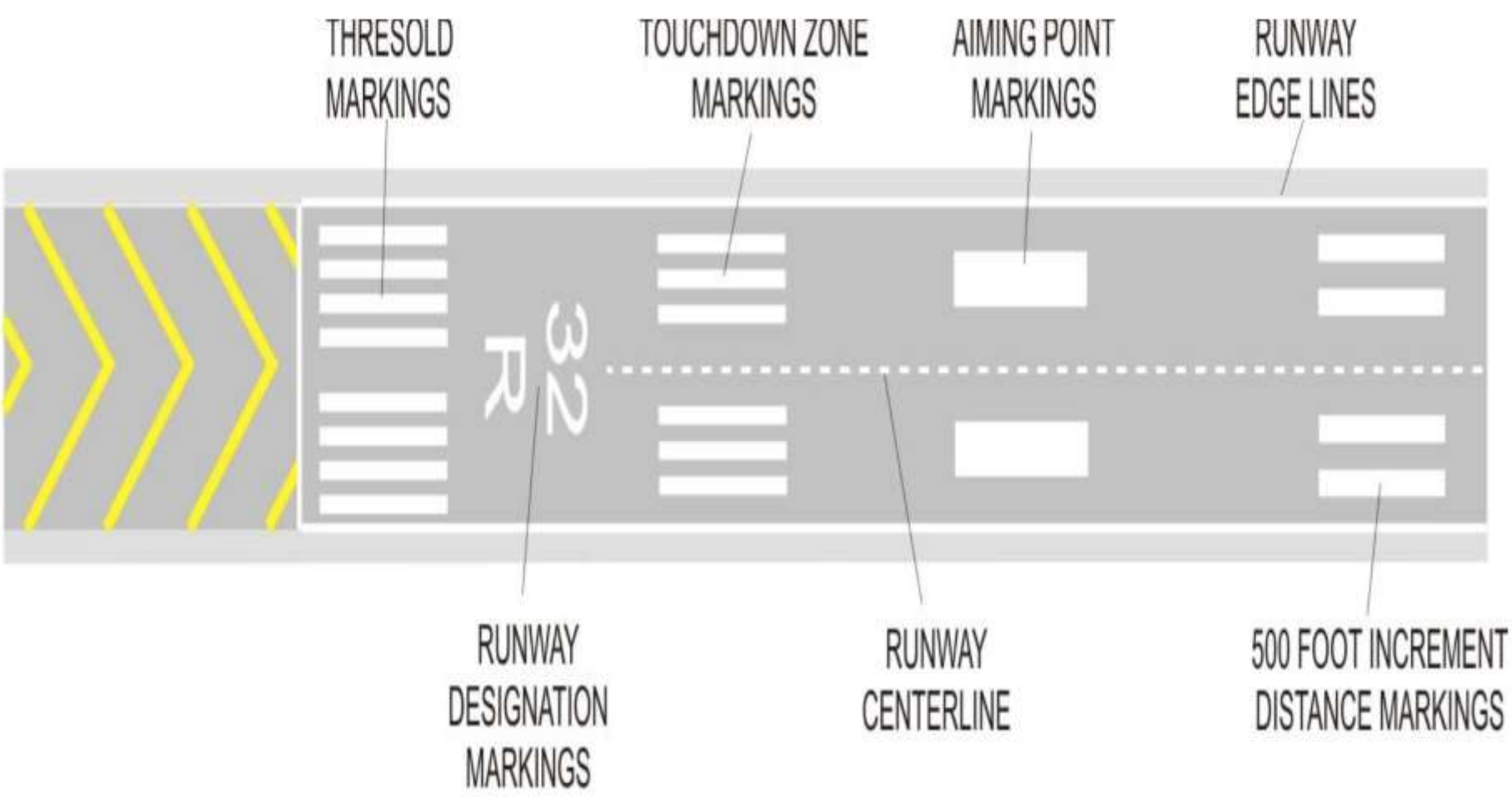


Design Criteria for Runway as per ICAO…

(VII) Threshold Marking:

- The runway threshold is indicated by series of parallel lines **spaced at 1 m** between adjacent, **starting from a distance of 6m from the runway end**
- The width and length of threshold should be **4m and 45 m** for A aswell as B types of runway respectively
- It is spaced symmetrically on either side of the runway centre-line.

Threshold Marking

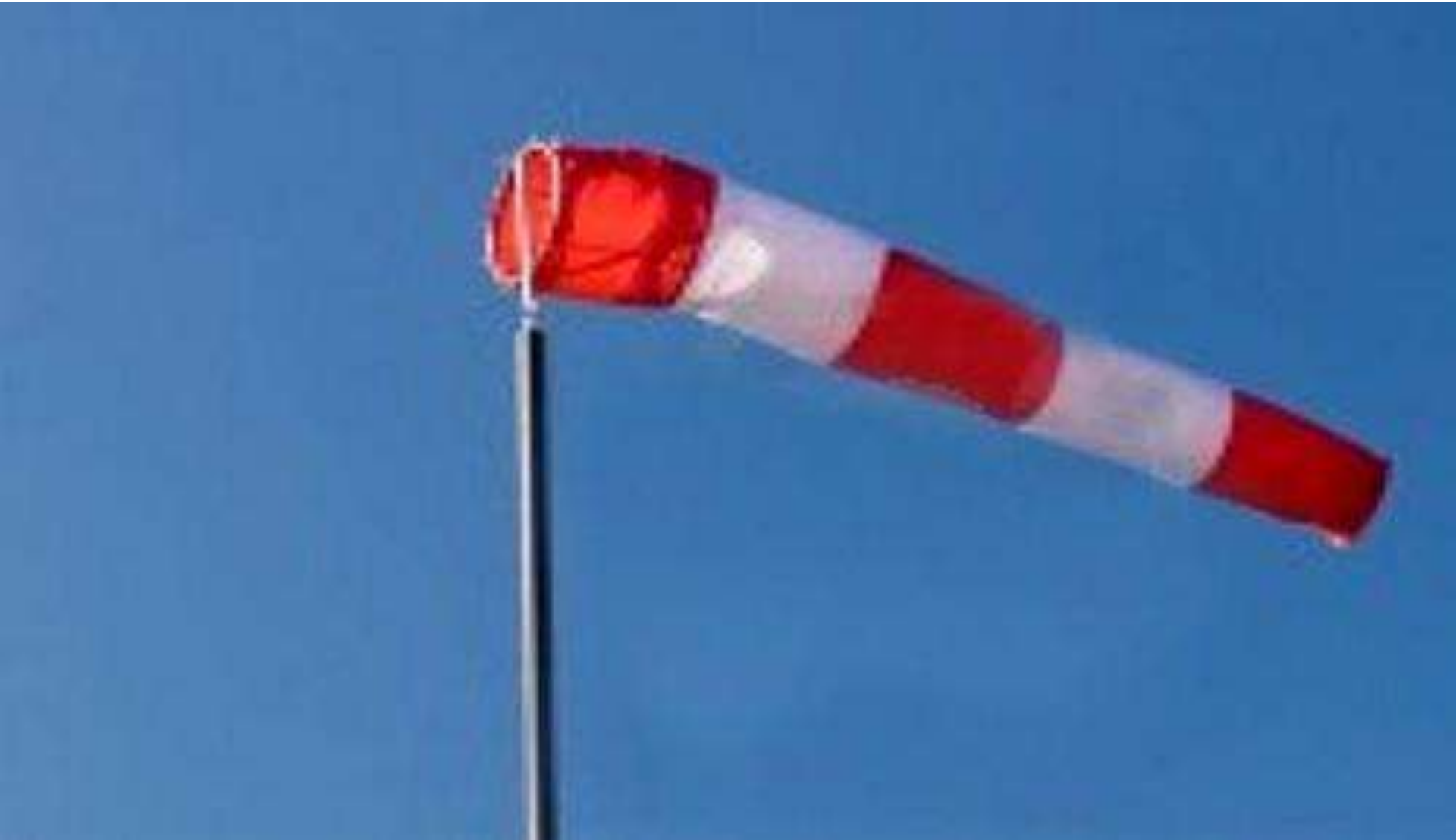


Design Criteria for Runway as per ICAO…

(VIII) Wind Direction Indicator:

- Represented by segmented circle.
- Inside diameter = 30 cm
- Larger end diameter = 90 cm
- Length of wind direction indicator = 3.6 m
- The color of wind direction indicator is White and Red (or Orange)

Wind Direction Indicator



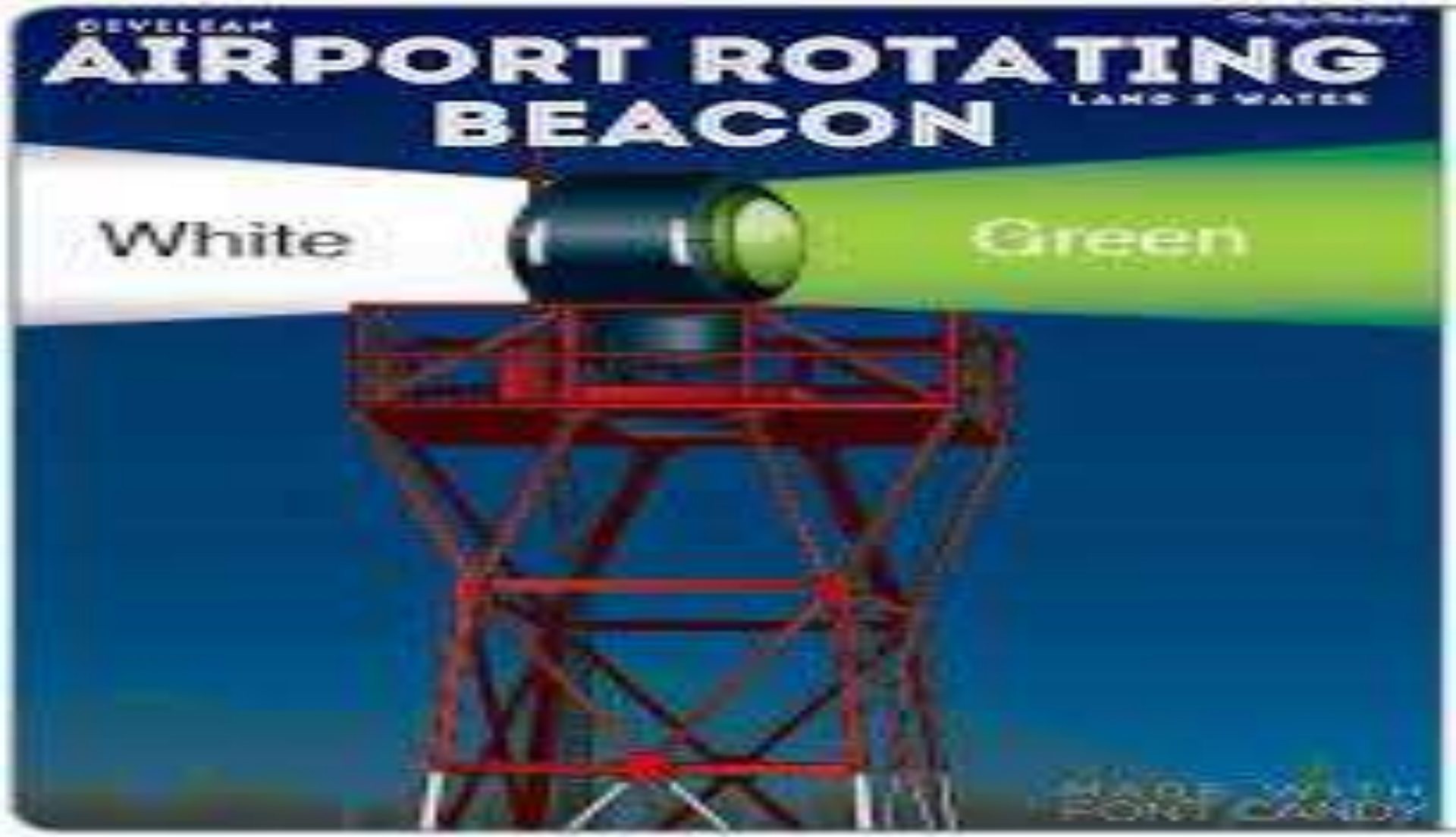
Design Criteria for Runway as per ICAO…

(IX) Airport Beacon:

Q. Define Airport Beacon (2 marks)

- A beacon is a strong beam of light which is used to indicate geographical locations.
- It consists of two 500 watts bulbs
- The rotating airport beacon gives out **white and green flashes** in the horizontal directions of 180 degree apart.
- It rotates six(6) revolutions per minute

Airport Beacon



Design Criteria for Runway as per ICAO…

(X) Approach lighting:

- Before runway starts, there is a sequence of high intensity lighting arrangements for a length of 900 m used by pilot for correct location of aircraft during landing.

Approach Lighting

Design Criteria for Runway as per ICAO…

(XI) Apron and Hanger Lighting:

- It is recommended that the lighting arrangements should be placed at the height of not less than 12 m from the pavement.

Apron Lighting

Design Criteria for Runway as per ICAO…

(XII) Boundary Lighting:

- The entire boundary of the airfield is provided with lights at a centre to centre spacing of above 90 m with a height of about 75 cm above the ground.
- Incase of fencing, these lights are placed at a distance of about 3 m inside the fence.
- The color of boundary light is red indicating hazardous approach.

Boundary Lighting

Design Criteria for Runway as per ICAO…

(XIII) Runway Lighting

- Flash type or they do not protrude more than 1 cm above the surface of the pavement.
- **Runway lights are white.**
- The spacing of lights are generally less than 60 m

Design Criteria for Runway as per ICAO…

(XIV) Taxiway Lighting:

- **The taxiway edge lights are blue and the centre line lights are green**.

(XV) Threshold Lighting:

- **Threshold lighting in the direction of landing are green** and in the opposite direction they are red to indicate the end of runway.

Threshold Lighting

Some Terminology (Important for 2 marks)

(I) **Airport Capacity**:

- The number of aircraft movement which an airport can process or handle within a specified period of time, usually an hour is called the airport capacity.

(II) **Airport Reference Point:**

- Approximate geometric centre of landing area is called airport reference point which is used to locate the location of airport on the map.

Some Terminology…

(III) Aircraft Speed:

- There are mainly two types of aircraft speed: Air-speed and ground speed.
- The speed of aircraft relative to wind is called airspeed while speed of aircraft relative to the ground is called ground speed (Cruising Speed)
- The indicated speed (via air speed indicator) is found slightly less than by about 2 % than the true air speed.

Some Terminology…

(IV) Beaufort Scale:

- It is the **scale showing the strength of air.**
- It consists of **13 numerical number 0 to 12.**
- Higher values are indicative of higher speed.
- Numeral **0 indicates the calm wind while 12 indicates hurricane**.

(V) **Calm Period**:

- The absence of applicable wind generally considered as 6 kmph or less is called calm period.

Some Terminology…

(VI) Black Box:

- It is flight data recorder and cockpit voice recorder.
- From black box, crash investigators find out what happened just before the crash.

(VII) Zero Fuel Weight:

- The weight of aircraft without fuel assuming that passenger and cargo are loaded as per maximum capacity.
- Zero Fuel Weight = Emptying operating weight + Maximum Payload

Some Terminology…

(VIII) Location Of Engine:

- The aeroplane may have one,two,three or four engines.
- The engine is placed in the nose of the aircraft for a single engine aircraft.
- If engines are two or four in numbers, they are placed symmetrically about the nose of the aircraft.
- Incase of aircraft with three engines, one is placed in the nose and one on each side of the wings.

Some Terminology…

(IX) **Wing Loading**:

- In aerodynamics, wing loading is the loaded weight of the aircraft divided by the area of the wing.

(X) Heliport:

- Space for the helicopter parking, building, servicing facilities and vehicular parking.
- The area from which the helicopter actually takes place or on which it lands is known as landing area.

Predicting Air travel demand

- In any travel mode, demand is continuously increasing at a significant rate, an estimate of the magnitude of demand is essential.
- The forcasting of future demand is difficult and uncertain procedure.
- Predicting air travel demand is necessary :
  - (1) To assist manufacture industry for aircraft order and to develop new aircraft.,
  - (2) For long term planning for both equipment and personnel.
  - (3) To assist government to facilitate the orderly development of the national and international airways system.

Methods of Forecasting

(1) Judgement :

- By a forecaster who is close to the problem and is able to integrate and balance the factors involved in the specific situations.

- (2) Surveys of expectations:
- Delphi analysis (Surveys of expectations)

- (3) Trend Forecasting:
- Extensive use
- Based on past growth figures

- $Tn = T0\ (1 + r)^n$
  - ***Tn*** - Traffic in the nth year
  - ***To*** - Traffic in the base year , ***n*** - Number of year
  - ***r*** - Annual growth rate of traffic expressed in decimals
  - **Limitations:**
  - Percentage of national growth does not remain constant
  - National forecast have been historically incorrect

- Number of trips made by the individual traveller depends not only on a number of socioeconomic variables such as income, employment type and family structure but also on system based variables such as frequency and level of service.