18CED41

Hall Ticket Number:

IV/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

November,2022 **Civil Engineering**

Seventh Semester **Railway and Airport Engineering**

Time: Three Hours **Maximum: 5**0 Marks

Answer Question No. 1 Compulsorily. (10X1 = 10 Marks)

*Answer **ANY ONE** question from each Unit.* (4X10=40 Marks)

1.	a)	Write any two functions of rails.	CO1(BL1)	
	b)	What are the different materials that can be used as a ballast?	CO1(BL1)	
	c)	What is negative super elevation?	CO2(BL1)	
	d)	List the classification of signals in railways.	CO2(BL1)	
	e)	Mention the limitations for air transport?	CO2(BL1)	
	f)	Write a short note on zoning laws	CO1(BL1)	
	g)	What is windrose diagram?	CO3(BL1)	
	h)	Which parameter of soil will be known by conducting CBR test?	CO3(BL1)	
	i)	Explain break waters.	CO4(BL1)	
	j)	Write the classification of harbors.	CO4(BL1)	
		Unit - I		
2.	a)	Differentiate roadways with railways.	CO1(BL1)	**5M**
	b)	Explain all the components of the permanent way using a neat sketch.	CO1(BL1)	**5M**
		(OR)		
3.	a)	Enumerate the functions of rails. Discuss about various types of rails.	CO1(BL1)	**5M**
	b)	Classify the various types of sleepers.	CO1(BL2)	**5M**
		Unit - II		
4.	a)	What is a crossing? What are the requirements of good crossing?	CO2(BL1)	**5M**
	b)	A curve of 6^o is situated on a BG track. If the maximum permissible speed on the curve is 65 kmph, determine the equilibrium cant. What is the maximum speed that can be permitted allowing maximum cant deficiency?	CO2(BL2)	**5M**
		(OR)		
5.	a)	Draw a neat sketch of a left-hand turnout explaining its components.	CO2(BL1)	**5M**
	b)	Explain the necessity of gradients. Discuss the types of gradients giving their permissible values adopted in Indian railways.	CO2(BL1)	**5M**
		Unit - III		
6.	a)	Explain aircraft characteristics in detail?	CO3(BL1)	**5M**
	b)	What are the factors to be considered while selecting the airport site?	CO3(BL1)	**5M**
		(OR)		
7.		The length of runway under standard conditions is 1500m. The airport site has an elevation of 300m. Its reference temperature is 37.94^0 C. If the runway is to be constructed with an effective gradient of 0.15%, determine the corrected runway length.	CO3(BL3)	**10M**
		Unit - IV		
8.	a)	Explain about CBR method of pavement design.	CO4(BL2)	**5M**
	b)	Explain the factors to be considered for the design of Airport Pavements.	CO4(BL2)	**5M**
		(OR)		
9.	a)	Write short notes on Wharves and jetties.	CO4(BL1)	**5M**
	b)	What are the requirements of a good port?	CO4(BL1)	**5M**

SCHEME OF EVALUATION

November,2022 **Civil Engineering**

Seventh Semester **Railway and Airport Engineering**

Time: Three Hours **Maximum:** 50 Marks

Answer Question No. 1 Compulsorily. (10X1 = 10 Marks)

*Answer **ANY ONE** question from each Unit.* (4X10=40 Marks)

1. a) Write any two functions of rails. **1M**

Sol:

1. Rails provide a hard, smooth and unchanging surface for passage of heavy moving loads with a min friction between the steel rails and wheels.
2. Rails bear the stresses developed due to heavy vertical loads, lateral and braking forces and thermal stresses.
3. Rails materials should give minimum wear and tear.

b) What are the different materials that can be used as a ballast? **1M**

Sol: The different materials used for ballast are

1.Broken stone 2.Gravel or river pebbles or shingle 3.Ashes or cinders 4.Sand 5.Moorum 6.Kankar 7.Brick ballast 8.Selected earth

c) What is negative super elevation? **1M**

Sol: The amount by which outer rail of branch line is lower than the inner rail is called negative super elevation.

d) List the classification of signals in railways. **1M**

Sol: Classification of signals

Signals can be classified based on following different characteristics

i)Operational characteristics

ii)Functional characteristics

iii)Locational characteristics

iv)Special characteristics

e) Mention the limitations for air transport? **1M**

Sol:

(i) Cost of operating airlines is very high and so freight cost is very high as compared to sea transport.

(ii) It is difficult to carry bulky, awkwardly shaped goods.

(iii) Very risky in case of accident.

(iv) It is controlled by climatic conditions; thus bad weather leads to uncertainty in its time table.

f) Write a short note on zoning laws **1M**

Sol:

- Airport should be selected that it does not obstruct the safe landing and take-off of aircrafts
- Steps should be taken to curb the possibility of developing any future obstruction
- The use of land for manufacture of items which may result smoke nuisance, foul odour etc. is controlled by the zoning laws
- zoning laws regarding the height of structures and the land use within the airport boundary should be implemented as soon as the site selected
- All zoning ordinances are reasonable, otherwise they will create resentment from the public and may result in mass disobedience.

g) What is windrose diagram? **1M**

Sol: The wind data, i.e., direction, duration and intensity are graphically represented by a diagram called wind rose.

h) Which parameter of soil will be known by conducting CBR test? **1M**
Sol: Strength of subgrade soil.

i) Explain break waters. **1M**
Sol: Breakwaters are structures constructed near the coasts as part of coastal management or to protect an anchorage from the effects of waves and long shore drift.
There are three types of break water
a) Rubble Mound type
b) Composite type
c) Vertical wall type
i) Rubble Mound Type

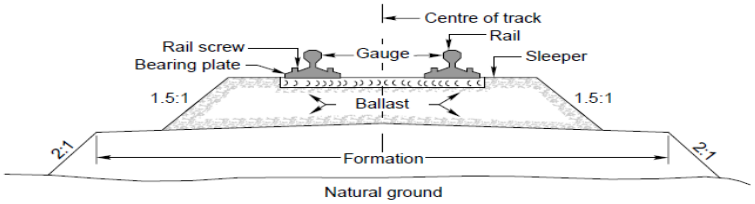
j) Write the classification of harbors. **1M**
Sol:
Classification of harbors depending upon the protection needed.
Classification depending upon the utility
Classification based upon the location.

Unit - I

2. a) Differentiate roadways with railways. CO1(BL1) **5M**
Sol: Write any five differences 5M

Characteristics	**Railway transport**	**Highway transport**
Tractive resistance	1/5 of pneumatic type	5 to 6 times more than railway vehicles
Load handling	Railways can handle heavier loads at high speed	Can handle low loads
Right of entry	Rigid and well defined path, right of entry not free to all	Free and flexible, every body has right
Operational controls	Block system,singnalling and interlocking	No such control
Gradient	For carrying heavy loads at high speeds on railway , the gradient must minimum	Steeper gradient when compared with the railway
Construction and maintenance cost	Much higher than roads	less
Origin and destination	Starting and destination points are fixed	Receiving and delivering of the goods can be done at any point
Accident rate	Few Faccident	Very large
Right of way	Lesser	Greater

b) Explain all the components of the permanent way using a neat sketch. **5M**
Sol:



Cross Section of a Permanent Way 2M

Rails: Rails are the members of the track laid in two parallel lines to provide an unchanging, continuous, and level surface for the movement of trains. To be able to withstand stresses, they are made of high-carbon steel.

Sleepers: Sleepers are the transverse ties that are laid to support the rails. They have an important role in the track as they transmit the wheel load from the rails to the ballast. Several types of sleepers are in use on Indian Railways.

Ballast: The ballast is a layer of broken stones, gravel, moorum, or any other granular material placed and packed below and around sleepers for distributing load from the sleepers to the formation. It provides drainage as well as longitudinal and lateral stability to the track.

Subgrade & formation: Subgrade is the naturally occuring soil which is prepared to receive the ballast.The prepared flat surface, which is ready to receive the ballast, sleepers, and rails, is called the formation. The formation is an important constituent of the track, as it supports the entire track structure. 3M

(OR)

3. a) Enumerate the functions of rails. Discuss about various types of rails. **5M**

Sol: Functions of rails:

- Rails provide a hard, smooth and unchanging surface for passage of heavy moving loads with a minimum friction between the steel rails and wheels.
- Rails bear the stresses developed due to heavy vertical loads, lateral and braking forces and thermal stresses.
- Rails materials should give min. wear and tear.
- Rails transmit the loads to sleepers and consequently reduce pressure on ballast. 2M

Types of rails:

1.Double headed rails: Idea behind using double headed rails was that when the head was worn out in course of time, the rail can be inverted reuse.

2.Bull headed rails: Bull headed rails head was made little thicker and stronger than the lower part, so that even after wear, it can with stand stresses

3.Flat footed rails: Flat footed rails could be fixed to the sleeper directly and would eliminate the need for chairs and keys but it was observed that rail sink into the wooden sleeper, making spikes work loose. 3M

b) Classify the various types of sleepers. **5M**

Sol: Types of sleepers:

1.Wooden sleepers

2.Metal sleepers

a.Cast iron sleepers

b.Steel sleepers

3.Concrete sleepers

a.Reinforced concrete sleepers

b.Prestressed concrete sleepers 1M

Characteristics	**Wooden sleeper**	**Steel sleeper**	**C.I sleeper**	**Concrete**
Service life(Yrs)	12-15	40-50	40-50	40-50
Weight (kg)	83	79	87	267
Handling	Manual	Manual	Manual	No manual
Type of maintenance	Manual or mechanized	Manual or mechanized	Manual	Mechanized only
Cost of maintenance	High	Medium	Medium	low
Gauge adjustment	Difficult	Easy	Easy	Not possible
Track circuiting	Best	Difficult	Easy	Easy
Damage by white ants and corrosion	Can be damage by white ants	Corrosion is possible	Can be damage by corrosion	No damage
Track elasticity	Good	Good	Good	Best
Scrap Value	Low	Higher than wooden	High	None

4M

Unit - II

4. a) What is a crossing? What are the requirements of good crossing? **5M**

Sol:

Crossing: A crossing is a device introduced at the junction where two rails cross each other to permit the wheel flange of a railway vehicle to pass from one track to another. 4M

Requirements of good crossing:

1.The assembly of a crossing has to be rigid to stand against severe vibrations which cause loosening of the components. This can be achieved by the following ways:

(a) The use of sole plate at turned bolts for connecting the points and splice rails.

(b) The foot-flanges of the wing walls should also be rivetted to the sole

plate. 2M

2.The wear on parts of the wing rails, opposite the nose and also of nose itself must be protected. This can be achieved by use of special steel.

3.Crossing body should be as rigid as possible and as long as practicable. 2M

b) A curve of 6^o is situated on a BG track. If the maximum permissible speed on the curve is 65 kmph, determine the equilibrium cant. What is the maximum speed that can be permitted allowing maximum cant deficiency? **5M**

Sol:

Equilibrium cant

$e=GV^2/1.27R$

Where G=1.676m

V=65kmph

R=1720/6

e =19.38cm

Max. permissible cant = 16.5cm

For Broad gauge, the cant deficiency = 7.6cm 2M

Theoretical cant = Equilibrium cant + cant deficiency=(16.5+7.6)= 24.1cm

Calculation of Permissible speed:

Cant= $GV^2/1.27R$

$24.1 = 1.676*V^2/1.27(1720/6)$

V = 72.48 kmph

According to Railway Board's speed formula $V = 4.35(R-67)^{1/2}$ = 64.5kmph

Hence maximum Permissible speed (i.e., lower of the two values) = 64.5kmph

say 65 kmph 3M

(OR)

5. a) Draw a neat sketch of a left-hand turnout explaining its components. **5M**

Sol:

Direction of a turnout: A turnout is designated as a right-hand or a left-hand turnout depending on whether it diverts the traffic to the right or to the left. In the below Figure, the turnout is a left-hand turnout because it diverts as the traffic towards the left side. The direction of a point (or turnout) is known as the facing direction if a vehicle approaching the turnout or a point has to first face the thin end of the switch. The direction is trailing direction if the vehicle has to negotiate a switch in the trailing direction i.e., the vehicle first negotiates the crossing and then finally traverses on the switch from its thick end to its thin end. Therefore, when standing at the toe of a switch, if one looks in the direction of the crossing, it is called the facing direction and the opposite direction is called the trailing direction.

Tongue rail: It is a tapered movable rail, made of high-carbon or -manganese steel to withstand wear. At its thicker end, it is attached to a running rail. A tongue rail is also called a switch rail. 2M

Stock rail: It is the running rail against which a tongue rail operates.

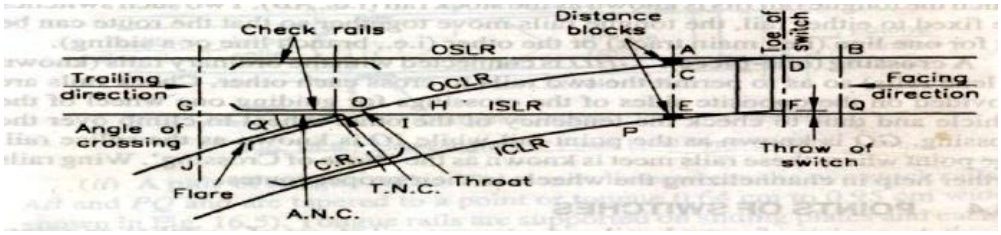


Figure: Left-Hand Turnout

Points or switch: A pair of tongue and stock rails with the necessary connections and fittings forms a switch.

Crossing: A crossing is a device introduced at the junction where two rails cross each other to permit the wheel flange of a railway vehicle to pass from one track to another. 3M

b) Explain the necessity of gradients. Discuss the types of gradients giving their permissible values adopted in Indian railways. **5M**

Sol: Necessity of gradients: To provide a uniform rate of rise or fall to the track. To reduce the cost of earthwork. To reach different stations at different elevations etc

Gradient: A gradient is normally represented by the distance travelled for a rise or fall of one unit. Sometimes the gradient is indicated as per cent rise or fall.

Types of gradients:

Ruling Gradient:

The ruling gradient is the steepest gradient that exists in a section. It determines the maximum load that can be hauled by a locomotive on that section. While deciding the ruling gradient of a section, it is not only the severity of the gradient but also its length as well as its position with respect to the gradients on both sides that have to be taken into consideration. The power of the locomotive to be put into service on the track also plays an important role in taking this decision, as the locomotive should have adequate power to haul the entire load over the ruling gradient at the maximum permissible speed. In plain terrain: 1 in 150 to 1 in 250.

In hilly terrain: 1 in 100 to 1 in 150

Pusher or Helper Gradient:

In hilly areas, the rate of rise of the terrain becomes very important when trying to reduce the length of the railway line and, therefore, sometimes gradients steeper than the ruling gradient are provided to reduce the overall cost. In such situations, one locomotive is not adequate to pull the entire load, and an extra locomotive is required. When the gradient of the ensuing section is so steep as to necessitate the use of an extra engine for pushing the train, it is known as a pusher or helper gradient. Examples of pusher gradients are the Budni–Barkhera section of Central Railways and the Darjeeling Himalayan Railway section. 3M

Momentum Gradient:

The momentum gradient is steeper than the ruling gradient and can be overcome by a train because of the momentum it gathers while running on the section. In valleys, a falling gradient is sometimes followed by a rising gradient. In such a situation, a train coming down a falling gradient acquires good speed and momentum, which gives additional kinetic energy to the train and allows it to negotiate gradients steeper than the ruling gradient. In sections with momentum gradients there are no obstacles provided in the form of signals, etc., which may bring the train to a critical juncture.

Gradients in Station Yards:

The gradients in station yards are quite flat due to the following reasons.

(a) To prevent standing vehicles from rolling and moving away from the yard due to the combined effect of gravity and strong winds.

(b) To reduce the additional resistive forces required to start a locomotive to the extent possible.

It may be mentioned here that generally, yards are not levelled completely and certain flat gradients are provided in order to ensure good drainage. The maximum gradient prescribed in station yards on Indian Railways is 1 in 400, while the recommended gradient is 1 in 1000. 2M

Unit - III

6. a) Explain aircraft characteristics in detail? **5M**

Sol:

1.Type of propulsion:

- Several types like piston engine, turbo prop etc.
- The size of aircraft, its circling radius, speed characteristics, weight carrying capacity, noise nuisance etc. depend upon the type of propulsion of the aircraft
- The performance characteristics of aircraft, which determine the basic runway length, also depend upon the type of propulsion
- The heat nuisance due to exhaust gases is a characteristic of turbo jet and turbo prop engines

2.Size of aircraft:

- Size of aircraft involves wing span, fuselage length, height, distance between main gears, wheel base and tail width
- Wing span decides width of taxiway, separation clearance between two parallel traffic ways etc.
- Length of aircraft decides the widening of taxiways on curves, size of aprons and hangars
- Height of aircraft decides the height of hangar gate and miscellaneous installations inside the hangar

3.Minimum turning radius:

- To determine the minimum turning radius, a line is drawn through the axis of the nose gear when it is at its maximum angle of rotation.
- The point where this line intersects another line drawn through the axis of the two main gears is called the centre of rotation
- The distance of the farther wing tip from the centre of rotation represents the minimum turning radius
- Theoretically, max. angle of rotation is 90 degrees. Corresponding to this turning radius will be absolute minimum. This causes excessive tire wear. 3M

4.Minimum circling radius:

- This is the minimum radius with which the aircraft can take turn in space
- This radius depends upon the type of aircraft, air traffic volume and weather conditions
- Small aircrafts under UFR conditions – 1.6 km
- Bigger aircrafts under VFR conditions – 3.2 km
- Piston engine aircrafts under IFR conditions – 13 km
- Jet engine aircrafts under IFR conditions – 80 km

5.Speed of aircraft:

- Speed of aircraft can be divided in two ways viz. cruising speed or ground speed and air speed
- Cruising speed is the speed of aircrafts with respect to the ground when the aircraft is flying in air at its maximum speed
- Air speed is the speed of aircraft relative to wind
- If the aircraft is flying at a speed of 500 kmph and there is a head wind of 50 kmph, air speed will be 450 kmph

6.Capacity of aircraft:

- The number of passengers, baggage, cargo and fuel that can be accommodated in the aircrafts depends on the capacity of aircraft
- Capacity of aircraft effects capacity of runway systems and passenger processing terminal facilities. 2M

b) What are the factors to be considered while selecting the airport site? **5M**

Sol: Factors considered for selection of suitable site

Regional plan

- Site selected should fit well into the regional plan and thereby forming it an integral part of the national network of airport

Airport use

- Selection of site depends on use of airport i.e. whether for civilian or military operations
- During emergency, civilian airports are taken over by the defense. Hence site should provide natural protection to the area from air raids

Proximity to other airports

- Site should be selected at a considerable distance from the existing airports so that the aircraft landing in one airport does not interfere with the movement of aircraft at other airport

- Separation between airports depends upon the volume and type of aircraft, air traffic control etc. 2M

Ground accessibility

The air line passenger more concerned with his door-to-door time rather than the actual time in air travel, hence site should be readily accessible to users

- The time required to reach an airport in a passenger car from business or residential centre, should normally not exceed 30 minutes
- The best location is a site adjacent to the main highway, this provides quick access and minimizes the cost of an entrance road
- Availability of public transportation facilities, e.g. bus, taxi etc. further qualifies the suitability of the site

Topography

A raised ground e.g. a hill top, is usually considered to be an ideal site for an airport.

Availability of utilities from town

Airport has to be provided with facilities like water supply, sewer, telephone, electricity etc. availability of these utilities from town should be considered.

3M

(OR)

7. The length of runway under standard conditions is 1500m. The airport site has an elevation of 300m. Its reference temperature is 37.94^0 C. If the runway is to be constructed with an effective gradient of 0.15%, determine the corrected runway length. **10M**

Sol:

1. Correction for elevation:

= 7/100*1500*300/300=105m

Corrected length= 1500+105=1605m 3M

2. Correction for temperature:

Standard atmospheric temperature = 15 – (0.0065*300) = 13.05^0C

Rise in temperature = 37.94-13.05=24.89^0C

Correction =1605/100*24.89=399.48m

Corrected length=1605+399.48=2004.48m 3M

Check for Total correction :

Total correction in %=(2005-1500)/1500*100=33.66%

According to ICAO this should not exceed 35% 2M

Correction for gradient:

=20/100*2005*0.15=60.15m

Corrected length=2005+60.15=2065.15m

Hence corrected runway length rounding to the nearest 10 is 2070m 2M

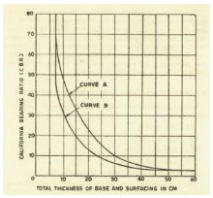
Unit - IV

8. a) Explain about CBR method of pavement design. **5M**

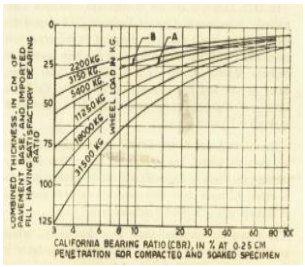
Sol:

CBR method:

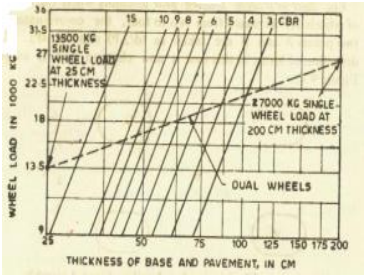
In 1928, California division of highways, developed CBR method. Subsequently, Corps of Engineers, USA adopted this method during world war II for designing the Military airport pavements. Based on the field investigations carried out by California division of highways, am Empirical relation was developed as shown in figure below



The curves A and B were satisfactory for highway loading and since the aircraft loads were much higher than highway loadings, the corps of engineers used the designed chart as given in figure using stress computations.



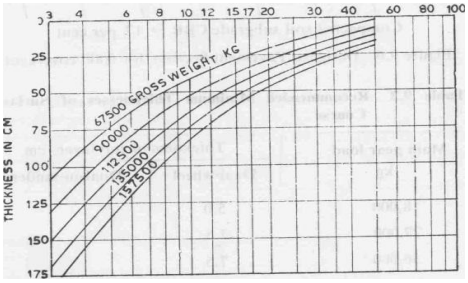
To obtain the ESWL of dual wheel assembly the below figure is used.



3M

No of design charts are developed by corps of engineers for different group wheel loadings and tire pressures. One typical design chart is given below.

CBR (%)



The corps of engineers anticipate about 5000 coverages in the life of pavement and for coverages more than 5000 it is recommended to increase thickness as under. 2M

Coverages	% increase in design thickness
10,000	7
15,000	11
20,000	14

b) Explain the factors to be considered for the design of Airport Pavements. **5M**

Sol: The following design factors are considered pavement design:

1.Design wheel load:

Airport pavements are designed for the wheel configurations

Aircrafts are supported by a nose gear and two main landing gears.

Each landing gear consists of one, two or four wheels. 2M

2.Strength characteristics of materials used in layers:

The strength characteristics of different pavement layers are evaluated in different manners as per each design method Largely, CBR or plate bearing tests are carried out for flexible material. For rigid material like cement concrete mix, the flexural strength, elastic modulus and Poisson's ratio are obtained as strength parameters.

3.Subgrade supporting capacity:

The supporting capacity of the subgrade is considered significant in flexible pavements.

In case of rigid pavements, this value seems to influence the thickness requirement negligibly. 3M

(OR)

9. a) Write short notes on Wharves and jetties. **5M**

Sol: Wharves: These are the platforms at which vessels take on and discharge passengers and cargo. In other words, they are docks that parallels the shore. They should be located in such a way as to give sufficient depth of water for the ship to float. They are built generally continuous with the shore but may not necessarily be so. They project out into or on to the water. Wharves built parallel with the shore are called quays. The walls are built to protect the quays are known as quay walls. They are built to retain and protect the embankment or filling. The Wharves design involves making provision for the berthing of the ship, handling and storage of cargo, and terminal facilities for rail and truck transportation. The type of vessel to be accommodated governs the length of wharf

They are two types:

1.Open Type Wharves

2.Solid Type Wharves 3M

Jetties: A jetty is a long, narrow structure that protects a coastline from the currents and tides. Jetties are usually made of wood, earth, stone, or concrete. They stretch from the shore into the water. Currents and tides of an ocean can gradually wash away a beach or other features along the coastline. 2M

b) What are the requirements of a good port? **5M**

Sol:

- It should be located centrally for the hinter land.
- It should get good tonnage.
- The hinter land should be fertile with good density population. 2M
- The hinter land should be advanced in culture, trade and industry.
- It should be capable of easy, smooth and economic growth.
- It should have good communication with the rest of country.
- It should be populous. 3M

Dr. Ch. Naga Satish Kumar
Professor & Head
Department of Civil Engg.
BEC,Bapatla

T.Chiranjeevi
Asst. Professor,
Subject Co-Ordinator-1
Department of Civil Engg.
BEC, Bapatla
Ph No: +91 - 9985838081