

SUMMER – 19 EXAMINATION

Subject Name: Highway Engineering (HEN) Model Answer Subject Code:

Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.Sub Q. N.AnswerMarking Scheme1(a) (i)Attempt any <u>THREE</u> of the following : State any four characteristics of road transport. (i)(12) State any four characteristics of road transport. (1)(14) (4M)Ans.Characteristics of road transport:- 1)1)(1) The roads are the connecting links between the various regions or parts of a country.(14) (4M)Ans.Characteristics of road transport is chaper. 3)(Any four)4)Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service)15)Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience. 6)16)Road transport saves time of travel for short distance and also saves the time of light traffic. 7)17)Roads are used by various types of road vehicles. 8)(4 M)Ans.The urban roads are classified as: 1)11)Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. 2)11)Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3)13)Collector streets: the street which provides access to abutting streets and they collect and distribute traffic from and to local streets is known as collector streets. 4)1				
1 (a) Attempt any <u>THREE</u> of the following : (12) (i) State any four characteristics of road transport. (4 M) Ans. Characteristics of road transport:- 1) The roads are the connecting links between the various regions or parts of a country. (4 M) (a) No. Construction and maintenance of road transport is cheaper. (Any four) (b) Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service) 1 Mark each (c) State the classification of counce the according to need and convenience. (Any four) (a) Road transport saves time of travel for short distance and also saves the time of light traffic. (A M) (a) Road transport saves time of travel for short distance and also saves the time of light traffic. (A M) (b) Road transport saves time of travel for short distance and also saves the time of light traffic. (A M) (ii) State the classification of urban roads (4 M) (iii) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. 1 Mark (a) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the	Q. No.	Sub Q. N.	Answer	Marking Scheme
(i)State any four characteristics of road transport.(4 M)Ans.Characteristics of road transport:-1)1)The roads are the connecting links between the various regions or parts of a country.1)2)It requires relatively less investment by the government.(Any four)3)Construction and maintenance of road transport is cheaper.(Any four)4)Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service)1 Mark5)Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience.66)Road transport saves time of travel for short distance and also saves the time of light traffic.7)7)Roads are used by various types of road vehicles.8)8)Degree of accidents is more but severity of accident is less.(4 M)Ans.The urban roads are classified as:1)1)Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.1 Marka)Collector streets: the street which provide access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets.1 Mark	1	(a)	Attempt any <u>THREE</u> of the following :	(12)
Ans.Characteristics of road transport:-I) The roads are the connecting links between the various regions or parts of a country.2)11 requires relatively less investment by the government.I) The roads are the connecting links between the various regions or parts of a country.3)Construction and maintenance of road transport is cheaper.(Any four)4)Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service)1 Mark5)Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience.I) Road transport saves time of travel for short distance and also saves the time of light traffic.7)Roads are used by various types of road vehicles.B) Degree of accidents is more but severity of accident is less.(ii)State the classification of urban roads(4 M)Ans.The urban roads are classified as:1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.1 Mark2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads.1 Mark3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets.1 Mark4) Local streets: The streets which provide access to abutting streets are known as local1 Mark		(i)	State any four characteristics of road transport.	(4 M)
1) The roads are the connecting links between the various regions or parts of a country.1) The roads are the connecting links between the various regions or parts of a country.2) It requires relatively less investment by the government.3) Construction and maintenance of road transport is cheaper.(Any four)4) Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service)1 Mark each5) Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience.each6) Road transport saves time of travel for short distance and also saves the time of light traffic.7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less.(4 M)Ans.The urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.1 Mark each2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads.1 Mark each3) Collector streets: the street which provides access to arterial streets and they collect 		Ans.	Characteristics of road transport:-	
country.(Any four)2)It requires relatively less investment by the government.(Any four)3)Construction and maintenance of road transport is cheaper.(Any four)4)Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service)1 Mark5)Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience.each6)Road transport saves time of travel for short distance and also saves the time of light traffic.7)7)Roads are used by various types of road vehicles.8)8)Degree of accidents is more but severity of accident is less.(4 M)Ans.The urban roads are classified as:1)1)Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.1 Mark2)Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads.1 Mark3)Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets.4)4)Local streets: The streets which provide access to abutting streets are known as local1			1) The roads are the connecting links between the various regions or parts of a	
2) It requires relatively less investment by the government. 3) Construction and maintenance of road transport is cheaper. (Any four) 4) Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service) 1 Mark each 5) Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience. each 6) Road transport saves time of travel for short distance and also saves the time of light traffic. 7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less. (4 M) Ans. The urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. 1 Mark 3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. 1 Mark			country.	
 3) Construction and maintenance of road transport is cheaper. 4) Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service) 5) Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience. 6) Road transport saves time of travel for short distance and also saves the time of light traffic. 7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less. (ii) State the classification of urban roads 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. 2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local 			It requires relatively less investment by the government.	
4) Road transport is a important access or way to reach a railway station, an airport terminal, bus station etc. (Road provides door to door service)1 Mark each5) Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience.6)6) Road transport saves time of travel for short distance and also saves the time of light traffic.7)7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less.(4 M)Ans.The urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.1 Mark each2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local1 Mark each			Construction and maintenance of road transport is cheaper.	(Any four)
terminal, bus station etc. (Road provides door to door service)each5) Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience.each6) Road transport saves time of travel for short distance and also saves the time of light traffic.for an approximation of travel for short distance and also saves the time of light traffic.7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less.(4 M)Ans.State the classification of urban roads The urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.(4 M)2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads.1 Mark each3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets.1 Mark each			4) Road transport is a important access or way to reach a railway station, an airport	1 Mark
5) Road transport offers a complete freedom to road users to transfer the vehicle from one lane to other according to need and convenience.6) Road transport saves time of travel for short distance and also saves the time of light traffic.7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less.(ii)State the classification of urban roads The urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local			terminal, bus station etc. (Road provides door to door service)	
from one lane to other according to need and convenience.6) Road transport saves time of travel for short distance and also saves the time of light traffic.7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less.(ii)State the classification of urban roads Ans.(iii)State the classification of urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.2)Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3)3)Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. 4)1 Mark each			5) Road transport offers a complete freedom to road users to transfer the vehicle	
 6) Road transport saves time of travel for short distance and also saves the time of light traffic. 7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less. (ii) State the classification of urban roads Ans. The urban roads are classified as: Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. Local streets: The streets which provide access to abutting streets are known as local 			from one lane to other according to need and convenience.	
light traffic.7) Roads are used by various types of road vehicles.8) Degree of accidents is more but severity of accident is less.(ii)State the classification of urban roadsAns.The urban roads are classified as:1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads.3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets.4) Local streets: The streets which provide access to abutting streets are known as local			6) Road transport saves time of travel for short distance and also saves the time of	
7) Roads are used by various types of road vehicles. 8) Degree of accidents is more but severity of accident is less.(4 M)(ii)State the classification of urban roads Ans.(4 M)Ans.The urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. 2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local			light traffic.	
8) Degree of accidents is more but severity of accident is less.(4 M)(ii)State the classification of urban roads(4 M)Ans.The urban roads are classified as:1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads.1) Arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads.1 Mark3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets.1 Mark each4) Local streets: The streets which provide access to abutting streets are known as local1			Roads are used by various types of road vehicles.	
 (ii) State the classification of urban roads (iii) Ans. The urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. 2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads.			8) Degree of accidents is more but severity of accident is less.	
 Ans. The urban roads are classified as: 1) Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. 2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local 		(ii)	State the classification of urban roads	(4 M)
 Arterial roads: The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. Local streets: The streets which provide access to abutting streets are known as local 		Ans.	The urban roads are classified as:	
 high level of traffic mobility are known as arterial roads. 2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3) Collector streets: the street which provides access to arterial streets and they collect each and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local 			1) Arterial roads: The streets primarily for through traffic on a continuous route, but with	
 2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but have a lower level of traffic mobility than the arterials are known as sub-arterial roads. 3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local 			high level of traffic mobility are known as arterial roads.	
have a lower level of traffic mobility than the arterials are known as sub-arterial roads.1 Mark 3) Collector streets: the street which provides access to arterial streets and they collect and distribute traffic from and to local streets is known as collector streets.1 Mark each 4) Local streets: The streets which provide access to abutting streets are known as local1 Mark			2) Sub-arterial roads: The streets primarily for through traffic on a continuous route but	
 3) Collector streets: the street which provides access to arterial streets and they collect each and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local 			have a lower level of traffic mobility than the arterials are known as sub-arterial roads.	1 Mark
 and distribute traffic from and to local streets is known as collector streets. 4) Local streets: The streets which provide access to abutting streets are known as local 			3) Collector streets: the street which provides access to arterial streets and they collect	each
4) Local streets: The streets which provide access to abutting streets are known as local			and distribute traffic from and to local streets is known as collector streets.	
			4) Local streets: The streets which provide access to abutting streets are known as local	

17602



		streets.	
	(iii)	State any four purposes of reconnaissance survey	(4 M)
	Ans.	The reconnaissance survey is carried out for following purposes:	
		1) To acquire general knowledge about topographical details of the area such as pond,	
		lake, river, valley, ridge, hill, marshy land, permanent structures and other	
		obstructions along the routes which are not shown on the map.	
		2) To collect geological information for foundation work of bridges and construction of	
		road pavements.	
		3) To collect information regarding the availability of local construction material and	
		labour.	(Any four)
		4) To determine the value of maximum gradient, radius of curves along alternative	1 Mark
		alignments.	each
		5) To locate the obligatory points along the alternative routes.	
		6) To prepare a rough estimate of the total cost of construction of the road along each	
		route.	
		7) To determine two or three best possible and economical routes for further study	
		based on practical consideration observed at site.	
	(iv)	Enlist the drawings required for road project.	(4 M)
	Ans.	Following are the various drawings required for the road project:	
		(1) Key map	
		(2) Index Map	
		(3) Preliminary Survey Plan	
		(4) Detailed location survey plan and longitudinal section	½ mark
		(5) Detailed cross-section	each.
		(6) Land acquisition plans (7) Drawing of Dood interpretions on Dood in stien	()
		(7) Drawing of Road Intersections or Road Junction	(Any
		(8) Drawing of cross drainage and masonry structures	eight)
		(9) Land plans for quarries	
1	(b)	Attempt any ONE of the following:	(6)
T	(i)	Calculate the stonning sight distance for two way traffic in a single lane road. The design	(0)
	(')	sneed is 74 Kmnh Assume reaction time of driver as 2.8 second coefficient of friction 0.6	
		brake efficiency as 50%.	(6 M)
	Ans.	Given data.	(0)
		V = 74 Kmph	
		t = 2.8 second	
		f = 0.6	
		brake efficiency = 50%	
		As the brake efficiency is 50 percent the wheels will skid through 50 percent of the braking	
		distance and rotate through the remaining distance. Therefore, the value of coefficient of	
		friction developed =f may be taken as 50 percent of the coefficient of friction.	
		i.e. f = (50/100) x 0.6 = 0.3	1 M
		SSD = $0.278 \text{ V t} + (\text{V}^2 / 254 \text{ f})$	1 M
		= (0.278 x 74 x 2.8) + (74 ² / (254 x 0.3))	
		= 57.60 + 71.86	
		SSD = 129.46 m. for one way traffic.	2 M
		SSD for Two Way traffic on single lane road = 2 x SSD for one way traffic	



			= 2 x 129.46 m		2.14
	()		= 258.92 m		2 171
	(11)	Calcu	late super elevation required for a road of 7.0 m will	de on curve of 250 m radius for	
	A 10 0	perm	issible speed of 100 kmph. The coefficient of friction	n IS 0.15.	(6 IVI)
	Ans.	Giver	I data,		
		V = 10	age way which of road = 7.0 m		
			50 m		
		$\mathbf{F} = \mathbf{O}^{\prime}$	15		
		1 – U Supoi	is colouption		
		Super	$\pm f = \frac{1}{2} \frac{1}{2$		2 1/1
			$-(1/2)/(1/27 \times R) = f$		2 101
		ρ	$(1002 / (127 \times 10)) = 0.15$		
		с- е=	0 165 m per meter length of carriage way		1 M
		or	$r = 0.165 \times 100 \text{ percent}$		T 101
		01	e = 16.50 % > 7 % (Restricted for plain terrain)		1 M
		There	fore provide maximum super elevation = $e = 7 \%$	i.e. $(7/100) = 0.07$ m per meter	
		lengt	h of carriage way		
		There	fore value of super elevation for 7.0 m wide road = 0).07 x 7 m	
			= 0.49 r	n	2 M
2		Atten	npt any <u>FOUR</u> of the following:		(16)
	(a)	Defin	e camber? State IRC values of camber for different i	roads.	(4 M)
	Ans.	Camb	per:		
		The c	convexity provided to the surface of carriage way o	r the rise given to the centre of	
		carria	ge way above its edges on straight portion of a road	is called "camber" or "cross fall"	2 M
		or "cr	oss slope".		
		Sr.	Type of road surface	Camber	
		NO.			
		1	High type bituminous surfacing and cement	1.7% to 2% (1 in 60 to 1 in 50)	
				20(+2) = 2 = 0(1) = 1 = 1 = 10	2 1/
		2	Mater bound massdam, gravel read surface	2% to $2.5%$ (1 III 50 to 1 III 40)	2 101
		5	Forth roads, footpaths ats	2.5% 10.3% (1 III 40 10 1 III 33)	
2	(1-)	4	Earth roads, hootpaths etc.	3% 10 4% (1 11 33 10 1 11 25)	(4.84)
Z	(D)	Defin	e overtaking zone? Why it is provided on highway.		(4 11)
	Ans.	Over	taking zone:	a longth of road visible aboad at	
			residue to construct highways in such a way that the point is sufficient for safe questaking. This is solds	ie length of foad visible affead at	
		every	point is sufficient for sale overtaking, this is selections where the safe overtaking distance cannot be	provided in such zones where	
		ovort	aking or passing is not safe or is not passible, sign pr	e provided. In such zones where	
		"No	aking of passing is not sale of is not possible, sign po passing" or "Overtaking Prohibited" before such	restricted zones start However	2 1/
		overt	aking on overtaking Frombled before such	ad should be given at as frequent	2 101
		inter	aking opportunity for venicles moving at design spec	overtaking are called 'overtaking	
		70000	als as possible. These zones which are meant for		
		Overt	,. aking zones are provided when 'Overtaking Sigh	t Distance' cannot be provided	
		throu	ghout the length of the highway. These are zones de	edicated for overtaking operation	
		mark	ed with wide roads. The desirable length of over	taking zones is 5 time OSD and	2 M
		minin	num is 3 times OSD.		<u> </u>



 Ans. Gradient: The rate of rise or fall provided to the formation of a road along its alignment is called "grade" or "gradient". (1) Ruling gradient: - The gradient usually adopted while making the alignment of a road is called "Ruling Gradient". This is such a gradient that all vehicles, whether drawn by power or by animals, can traverse long lengths of the road without undue consumption of fuel or much fatigue. (2) Limiting gradient: - The gradient steeper than the ruling which may be used in restricted road lengths where the later is not feasible is called "maximum or limiting gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	1 M 2 M (for any four – ½ M each)
 called "grade" or "gradient". (1) Ruling gradient: - The gradient usually adopted while making the alignment of a road is called "Ruling Gradient". This is such a gradient that all vehicles, whether drawn by power or by animals, can traverse long lengths of the road without undue consumption of fuel or much fatigue. (2) Limiting gradient: - The gradient steeper than the ruling which may be used in restricted road lengths where the later is not feasible is called "maximum or limiting gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	1 M 2 M (for any four − ½ M each)
 (1) Ruling gradient: - The gradient usually adopted while making the alignment of a road is called "Ruling Gradient". This is such a gradient that all vehicles, whether drawn by power or by animals, can traverse long lengths of the road without undue consumption of fuel or much fatigue. (2) Limiting gradient: - The gradient steeper than the ruling which may be used in restricted road lengths where the later is not feasible is called "maximum or limiting gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	2 M (for any four – ½ M each)
 road is called "Ruling Gradient". This is such a gradient that all vehicles, whether drawn by power or by animals, can traverse long lengths of the road without undue consumption of fuel or much fatigue. (2) Limiting gradient: - The gradient steeper than the ruling which may be used in restricted road lengths where the later is not feasible is called "maximum or limiting gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	2 M (for any four − ½ M each)
 drawn by power or by animals, can traverse long lengths of the road without undue consumption of fuel or much fatigue. (2) Limiting gradient: - The gradient steeper than the ruling which may be used in restricted road lengths where the later is not feasible is called "maximum or limiting gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	2 M (for any four – ½ M each)
 consumption of fuel or much fatigue. (2) Limiting gradient: - The gradient steeper than the ruling which may be used in restricted road lengths where the later is not feasible is called "maximum or limiting gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	2 M (for any four – ½ M each)
 (2) Limiting gradient: - The gradient steeper than the ruling which may be used in restricted road lengths where the later is not feasible is called "maximum or limiting gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	2 M (for any four − ½ M each)
 restricted road lengths where the later is not feasible is called "maximum or limiting gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	2 M (for any four – ½ M each)
 gradient". This type of gradient may be used where the topography of a place compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	2 M (for any four – ½ M each)
 compels this course or where the adoption of greater gradients would add enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	(for any four − ½ M each)
 enormously to the cost. (3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for 	four – ½ M each)
(3) Exceptional gradient: - The gradient steeper than the limiting which may be used in short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for	M each)
short lengths of the road, only in extraordinary situations, is called "Exceptional gradient". This type of gradient is adopted only in very difficult situations and for	
gradient" This type of gradient is adopted only in very difficult situations and for	
Student : this type of Student is duopted only in very difficult studions and for	
short lengths not exceeding 100 m at a stretch.	
(4) Average gradient: - The total rise or fall between any two points along the	
alignment of a road divided by the horizontal distance between them is called	
"average Gradient".	
(5) Floating gradient: - The gradient on which a motor vehicle, moving with a constant	
speed, continues to descend with the same speed without any application of power	
or brakes is called "floating gradient".	
(6) Minimum gradient: - The minimum desirable slope essential for effective drainage	
of rain water from the road surface is called "minimum gradient".	
IRC recommendation for gradient:	
Sr. Value of Gradients	
No. Ruing Limiting Exceptional	1 1 1
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	T IVI
02 Mountainous terrain(Area) 5.0% (1 in 20) 6% (1 in 16.7) 7.0% (1 in 14.3)	
03 Steep Area 6% (1 in 16) 7% (1 in 14.3) 8.0% (1 in 12.5)	()
2 (d) State the factors on which design speed depends.	(4 M)
Ans. The design speed depends on the following factors:	
(1) Class and condition of the road surface	
(2) Nature, intensity and type of trainc	
(3) Type of curve along the road	4 5 4
(4) Signit distance required	4 101
(5) Topography of the area	
(c) Importance of highway	
2 (e) State the uses of following equipments during construction of a highway:	
(i) Scrapper (ii) Grader	(A NA)
(ii) Glader	(4 101)
Alls. (i) Scraper. Scrapers are used for the following purposes:	
2) To load the excepted soil	
2) To transport the excavated soil	2 14
A) To dump the excavated soil at the required site	∠ IVI
(ii) Grader: A grader is mainly used for the following purposes:	



1) To give the proper shape to the road subgrade. 2) 1) To construct earth road quickly. 2 3) To spread the loose material evenly. 3) To spread the loose material evenly. 2 4) For general maintenance of roads during landslides and snow clearance. 2 2 (f) State the requirements of good quality material which plays the major role in highway construction. (4 Ans. The following are the requirements of good quality material which plays the major role in (4	е м • м)
2) To construct earth road quickly. 2 3) To spread the loose material evenly. 3) To spread the loose material evenly. 4) For general maintenance of roads during landslides and snow clearance. 2 2 (f) State the requirements of good quality material which plays the major role in highway construction. (4 Ans. The following are the requirements of good quality material which plays the major role in	2 M
3) To spread the loose material evenly. 4) For general maintenance of roads during landslides and snow clearance. 2 (f) State the requirements of good quality material which plays the major role in highway construction. Ans. The following are the requirements of good quality material which plays the major role in	[⊥] M)
4) For general maintenance of roads during landslides and snow clearance. 2 (f) State the requirements of good quality material which plays the major role in highway construction. Ans. The following are the requirements of good quality material which plays the major role in	• M)
 2 (f) State the requirements of good quality material which plays the major role in highway construction. (4 Ans. The following are the requirements of good quality material which plays the major role in 	M)
Ans. The following are the requirements of good quality material which plays the maior role in (4)	[↓] M)
Ans. The following are the requirements of good quality material which plays the major role in	
highway construction:	
(1) The highway material should be strong enough to take the traffic load.	
(2) The highway material should be durable to resist the weathering effect.	
(3) The highway material should be well graded to make the denser portion in any	
course of road.	/ four)
(4) The highway material should be easily available to the vicinity of road site.	, ∕Iark
(5) The highway material should have sufficient cementation property i.e. it should e	ach
have sufficient binding property within itself.	
(6) The highway material should have adhesive property i.e. it should have sufficient	
binding capacity with the binders.	
(7) The highway material should be economical as well.	
3 Attempt any FOUB of the following:	16)
(a) Define super elevation and state maximum and minimum values of super elevation. (4)	
Ans. Super elevation: The inward transverse inclination provided to the cross-section of the	,
carriage way at horizontal curved portion of a road is called super elevation, cant or	
hanking	М
Maximum Super elevation: IRC has recommended the following formula for calculating	
the maximum super elevation:	
$e = V^2 / (225 \text{ x B})$	
The super elevation obtained from the above formula should however be kept limited to	
the following values:	
Sr. Type of Area Value of Super elevation No. Volume of Super elevation	
1 For Plain and Rolling Areas 7 percent 2	M
2 In snow bound areas 7 percent	
3 In hilly area not bound by snow 10 percent	
Minimum Super elevation: IRC has recommended the following formula for calculating the	
minimum super elevation:	
$e = V^2 / (225 \text{ x R})$	
The super elevation obtained by the above formula, if less than the road camber, then the	
minimum super elevation to be provided on horizontal curve may be limited to the	
camber of the surface.	M
3 (b) Draw typical C/S of National highway cutting. (4	M)
Ans. Cross Section of National Highway is as below:	,
21	∕l for
Dia	gram
	J
	М
For	label



		ROAD STDE ROUNDRY ROUNDRY STORE CATER PREN	AL HIGHWAY (NH) IN CUTTING	1 M for dimension
3	(c)	State various types of curves provided on hill	road? Draw a neat sketch of any one.	(4 M)
	Δns	Types of curves provided on hill road are as fo	llow:	、 <i>,</i>
	7 (115)	(1) Upin nin hand survey The survey in a hill	I read which changes its direction through an	
		(1) Hair pin bend curve: The curve in a hin		
		angle of 180° or so, down the hill on th	ie same side is known as hair pin bend curve.	1 M
		(2) Salient curve: The curves having their	r convexity on the outer edges of a hill road	
		are called salient curves.		1 M
		(3) Re-entrant curve: The curves having the curves having the second s	heir convexity on the inner edge of a hill road	
		are called re-entrant curves.		1 M
		PARAPET WILL WILL HTT HTT HTT HTT HTT HTT HTT HTT HTT H	HILL SIDE HILL SIDE TRIA TO E VISIBILITY PO SALTENT EVE	1 M for any one diagram
3	(H)	Differentiate between flexible and rigid nave	ment	(4 M)
5	(⊶) ∆nc	Flavible Davament	Rigid Davement	(-+ 141)
	AIIS.		nigiu ravellielit	
		1) Its Initial cost Is IOW.	1) its initial cost is nign.	
		2) Its life span is short.	2) Its life span is long.	
		3) Its thickness is more.	3) Its thickness is less.	



		4) Joints are not required.	4) Joints are essentially required.		
		5) Moderate skill and less supervision is	5) High degree of skill and more		
		required.	supervision is required.		
		6) Its repair work is easy.	6) Its repair work is difficult.		
		7) A reasonably good subgrade is required.	7) A good subgrade is not necessary.		
		8) It can be opened to traffic shortly after	8) It requires curing after construction and		
		construction.	thus cause delay in opening to traffic.		
		9) It is less durable.	9) It is more durable.	(any four)	
		10) Stresses are not induced in these	10) Heavy stresses are induced in these	1 M each	
		pavements due to temperature variations.	pavements due to temperature variations.		
		11) It is resilient to traffic load.	11) It is less resilient to traffic load.		
		12) It is suitable for all types of traffic.	12) It become noisy under iron wheeled traffic.		
		13) It develops corrugations.	13) It does not develop corrugations.		
		14) It offers more tractive resistance.	14) It offers less tractive resistance.		
		15) B.T. pavements provide poor visibility			
		at night.	15) It provides good visibility at night.		
		16) Its maintenance cost is high	16) Its maintenance cost is low.		
3	(e)	Explain the procedure of WBM road construct	ction.	(4 M)	
	Ans.	The construction procedure of W.B.M. road is	discussed below:		
		1. Preparation of subgrade : The subgrade is p	prepared to the required grade and camber.		
		2. Preparation of the base course : After preparation of the base course and the preparation of the preparation of the base course and the preparation of the base course and the preparation of the preparation of the base course and the preparation of the preparation	paring the subgrade or sub base, the required		
	type of base course is constructed with specified materials in conformity with lines, grade			1 M	
		and thickness.			
		3. <u>Preparation of intermediate and wearing</u>	course: The preparation of intermediate and		
		wearing course of a WBM road is done in following steps:			
		(i) <u>Preparing the surface</u> :- The surface of the newly laid base course on which some			
		traffic has been allowed, is checked and the defective portions are rectified.			
	(ii) <u>Providing edging or earthen kerbs</u> :- After preparing the surface brick-on-end edging				
	is provided along the outer edges of the carriage way of the road.				
	(iii) <u>Spreading of coarse aggregate</u> :- The road metal is spread evenly over the prepared				
		base to the specified thickness.			
		(iv) <u>Dry rolling</u> :- After spreading the course	e aggregate, dry rolling is done by means of a		
		suitable roller. The rolling should be started f	from edges and gradually shifted towards the		
		centre after properly rolling each strip.			
		(v) <u>Spreading of screenings</u> :- After dry	rolling, a blindage layer consisting of stone		
		screenings (12 mm grits) is spread at a slow	and uniform rate so as to ensure filling of all		
		Voids.			
		(vi) <u>Wet rolling</u> :- After spreading the sc	reenings, the surface is sprinkled over with		
		sufficient quantity of water, swept and rolled.			
		(VII) Application of binding material, wat	ering and rolling :- After the application of		
		screening and wet rolling, the binding materi	at is applied successively in two or more thin		
		layers at a slow and uniform rate. After eac	ch application, the surface is freely sprinkled		
		with water and rolled with 6 to 10 tonne rolle	r.	2.14	
		(VIII) <u>Finishing the surface</u> :- After the fina	al compaction, road surface is allowed to dry	2 M	
		overnight.			
		(ix) <u>Setting and drying</u> :- The surface is then allowed to cure for 7 to 9 days.			



		4. Preparation of shoulders : During curing, the shoulders are prepared by filling earth to		
		the specified cross slope. These are then properly compacted by rolling or tamping.		
		5. <u>Open to traffic</u> : After drying, the road is opened to traffic.	1 M	
4	(a)	Attempt any <u>THREE</u> of the following:	(12)	
	(i)	Draw a neat sketch of a pavement. State the functions of each components.	(4 M)	
F	(i) Ans.	Attempt any <u>initial</u> of the following. Draw a neat sketch of a pavement. State the functions of each components. Image: State of a pavement. State the functions of each components. Image: State of a pavement. State the functions of each components. Image: State of a pavement. Image: State of each pavement component are as follow: (1) Function of Subgrade : (i) To bear ultimately the entire load of pavement including the load of traffic transmitted through the pavement. (ii) To provide an adequate and uniform support to the road pavement. (2) Function of Sub-base : (i) To improve the bearing capacity of the subgrade. (iii) To improve the bearing capacity of the subgrade. (iv) To prevent subgrade material form working up into the base course. (3) Function of Base course : (i) To withstand high shearing stresses imposed upon it due to impact of traffic on the wearing course. (ii) To act as foundation for the road pavement and to transfer the wheel loads coming over the pavement surface safely to the sub-base and subgrade lying underneath.	(12) (4 M) 1 M (for neat labeled diagram) 3 M (any three with two	
		 (4) <u>Function of Base coat</u>: (i) To transmit wheel loads coming on the pavement surface over larger area of the base course. (ii) To act as a layer of transmission material since, otherwise, there is great difference in size of aggregates used in wearing course and base course. (5) <u>Function of Wearing course</u>: (i) To distribute the traffic load safely to the base course. (ii) To act as an impervious layer so that the surface water may find its access to the base course. (iii) To prevent dust nuisance. (iv) To withstand abrasion caused due to movement of traffic. (v) To provide a smooth riding surface. 	function in each. 1 M each)	
	(ii)	Draw following traffic signs.		
		 1) Oneway 2) Stop 3) Speed Limit 4) No parking 	(4 M)	
	Ans.	1) One way:		



		1 M
	ONE WAY	
	2) Stop:	1 M
	3) Speed Limit	4.84
	SPEED LIMIT	1 M
	4) NO PARKING or	1 M
(iii) Ans.	Draw the sketches of Rotary interchange and Rotary island. The sketches are as below:	(4 M)
	(i) Rotary Interchange:-	
	(b) ROTARY INTERCHANGE	2 M
	(ii) Rotary Island:	



		181		
		(a) Circular Shape (b) Squarish Shape (c) Elliptical Shape (c)	2 M (for any one diagram from these four types)	
	(iv)	State the necessity of maintenance of roads.	(4 M)	
	Ans.	Following are the reasons which highlights the necessity of road maintenance:		
		(1) Road maintenance is necessary because timely and routine maintenance of the		
		road helps in preventing the accidents.		
		(2) Road maintenance is necessary to maintain various component of road like		
		road users		
		(3) Road maintenance is necessary to provide the safe and convenient movements of		
		passengers and goods at all the time.		
		(4) Road maintenance is necessary to maintain the road in the best possible condition		
		to enable the traffic to move smoothly and safely thereby decreasing the		
		inconvenient movement of traffic.		
		(5) Road maintenance is necessary to increase the life of the road.		
4	(b)	Attempt any <u>ONE</u> of the following:		
	(i) Ana	Define soil stabilized road? Explain any one method of soil stabilization.		
	ANS.	or two compacted layers of stabilized soil is called soil stabilized road or Stabilized earth		
		road	2 M	
		* Methods of soil stabilization : Following are the methods of soil stabilization:	2 111	
		1. <u>Mechanical Stabilization</u> : In this method the soil is tested. If the soil is coarse grained,		
		fine grained soil is so added that the proportion if coarse and fine grains is 2 and similarly,		
		if the soil is sandy, requisite quantity of clay is added to adjust the proportion. The soil is		
		ploughed to a depth of nearly 15 cm, and pulverized; and then the required quantity of fine		
		or coarse grains is added. After sprinkling water the surface is compacted by light rollers		
		and then to be cured for about 4 to 5 days.		
		2. <u>Cement Stabilization</u> : Cement is a binding material. When mixed with soil, it forms a sort		
		or low strength concreter in which the soil acts as aggregate and cement as matrix. So the		



	 soil is excavated to a depth of nearly 15 cm and 8% to 12% of cement is mixed. Sufficient quantity of water is then added and the soil cement mixture is compacted properly by road stabilizers. After it has been compacted it is then cured for about 7 to 8 days by simply sprinkling water over it. 3. Lime Stabilization: In this case the process of stabilization is similar to that of cement stabilization. The soil loosened, pulverized, sieved and mixed with 5 to 10% by weight of hydrated lime. The two are thoroughly mixed. Sufficient quantity of water is added and the surface is compacted. The lime helps in reducing the shrinkage and swelling of soil. 4. Bitumen Stabilization: In this method the soil is treated with about 8 to 10% of road oils, cut backs or emulsion, according to the nature of the soil. Their object is to glue together the soil particles and fill up the voids. 5. Chemical Stabilization: Hygroscopic materials such as calcium chloride, sodium chloride etc. are mixed with the soil at the rate of 1 kg per 5 sq. m. of the surface and the soil is thoroughly compacted. These hygroscopic materials help in retaining proper amount of moisture in the soil and add to its stabilizer used is known as grout. The usual grouting materials are cement, soil, bitumen and chemicals. Holes are driven at regular intervals and of desired depth and the grouting pump. The grout having the cementing properties will bind the soil particles. 7. Electrical Stabilization: Electrical stabilization is a method of drawing out the fine-grained soil by passing direct current through them. It is also sometimes called Electro-osmosis. With the damage of the fine particles the volume of the soil decreases i.e. the soil is consolidated and the shear strength in increased. This will ultimately lead to hardening of soil and process is sometimes known as electro-chemical hardening. 8. <u>Complex stabilization:</u> Complex stabilization is defined as the method of stabilization with	(any one method from these) 4 M
	electrolytes.	
(ii) Ans.	 Describe in brief with neat sketch joints in concrete road. The various joints in concrete roads are classified into the following two categories: Longitudinal joints. Transverse joints. (1) Longitudinal joints: The various types of longitudinal joints are described with its sketch as below: Plain butt join: It is the simplest type of longitudinal joint. It is formed by simply painting the joint faces with a sealing compound as shown in figure. 	(6 M)
	(ii) Butt joint with tie bars: In this type of longitudinal joint, tie bars of 12 to 15 mm diameter are provided. These tie bars are about 1 m in length and are placed at 600 mm centre to centre distance. The top of the joint is then sealed with sealing compound as	2 M (for any two 1 M each)



shown in figure	12mm SEALING
	THE BAR
	ROAD SLAB
(b) Butt joint with	RADE

(iii) Tongue and groove warping joint: In this type of longitudinal joint, a tie bar is inserted between the two strips with a key. The top of the joint is then sealed with a sealing compound as shown in figure.



(2) Transverse joints: The various types of transverse joints are described with its sketch as below:

(i) Expansion joints: The transverse joints constructed to allow for expansion of the road slab due increasing in temperature are known as expansion joints. These transverse joints are provided at right angles to the centre line of the road at 18 to 20 m intervals. These joints extend to the full width and thickness of the road slab as shown in figure.



(ii) Contraction joints: The transverse joints constructed to allow for contraction (Shrinkage) of the road slab due decreasing in temperature are known as contraction joints. These transverse joints are provided at 4 to 5 m intervals usually at right angles to the centre line of the road. These joints are either or plain butt type or dummy type joints as shown in figure.



(b) Dummy Type Contraction Joint

(iii) Warping joints: The transverse joints constructed to control the bending or warping of a road slab due to difference in moisture content or temperature at its top and bottom are known as warping joints. These joints are in the form of butt joints with tie bars as shown in figure.

4 M (1 M each)





Q. No.	Sub Q. N.	Answer	Marking Scheme
<u>о г</u>	2)	State was of traffic values study	
Q.5	d) Anc:	State uses of traffic volume study.	1M oach
	AIIS	Uses of traffic volume study.	
		1) Traffic volume is generally accepted as a true measure of the relative importance of roads	(ally four)
		2) Traffic volume study is used in planning, traffic operation and control of existing facilities	iour)
		and also for planning and designing new facilities.	
		3) This study is used in the analysis of traffic patterns and trends.	
		4) Classified volume study is useful in structural design of pavements, in geometric design	
		and in computing roadway capacity.	
		 Volume distribution study is used in planning one-way streets and other regulatory measures. 	
		6) Turning movement study is used in the design of intersections, in planning signal timings, channelization and other control devices.	
		Pedestrian traffic volume study is used for planning sidewalks, cross walks subways and pedestrian signals.	
	b)	State four preventive measures for landslides.	
	Ans:-	The landslides can be prevented by taking the following measures:	1M each
		1. Effective drainage system: - Landslides can be avoided by providing proper and effective	(any
		drainage system that is by providing catch water drains, cross drains etc.to intercept and	four)
		divert the water.	,
		2. Slopes: - By providing proper slopes and their treatment to minimize the erosion due to	





3. Support: - To support the earth fill by constructing retaining structure along with buttress at toe.

4. Soil stabilization: - Landslide may occur due to poor load bearing capacity of soil. By improving the stability conditions of soil by soil stabilization method the landslide may be avoided.

5. Angle of slope: - By reducing the angle of slope or by providing breast wall land slide which may occur due to increase in slope should be avoided.

6. Chemical treatment: - To enhance the properties of soil, chemical treatment may be adopted. It improves the load carrying capacity of soil and helps to avoid landslides.

7. Netting: - By providing jute netting or wire netting. It also helps to avoid landslides in case of hilly areas. Net which is made up of fibers such as jute net are provided in hilly areas to prevent landslides.

8. Asphalt mulch treatment: - By asphalt mulch treatment of the slopes and growth of vegetation can also avoid the landslides.

c) Draw a layout of Hot mix bitumen plant.



compaction of earth roads, WBM roads, and bituminous concentrated layers.



	ii) Sheep footed rollers – The sheep foot rollers consist of a hallow steel drum around its periphery of which welded projections or feet just like that of sheep are used. These are varies from 15-20 cm long. In the working of these rollers soil is supported to be compacted and consolidated. It is used for consolidation of earth embankments (cohesive soil), earth filling.	2M (any one)
	iii) Pneumatic rollers - In pneumatic rollers, its weight plays an important role while compacting soil with the help of kneading and vibrating. In this type of rolling compaction is due to its tyred wheel. The arrangement is made in so fashion that track of forward wheel is in between rear wheel. Thus uniform compaction is achieved while moving forward. The number of tyres can be 4 or more than 8 number of tyres and maximum weight after ball-asting may vary upto 200 MT. These rollers can compact upto a depth of 60 cm and are suitable for any type of soil.	
	 iv) Vibratory rollers - Vibratory rollers are the recent development of compacting dry and lean concrete. Heavy rollers which vibrates while rolling is used for the compaction of dry lean concrete. It is mainly used for construction of dam and pavements. v) Rammers or Hand operated compactors - Ramming is one of the method used in hand 	
	compaction. It should be done with care. The light ramming is permitted in case of unreinforced foundation concrete or in ground floor construction. It is not used in case of RCC or where the concrete is to be placed in the formwork supported on struts as it may adversely affect reinforcement and may disturb it. It is also used for compaction of trenches, slopes, behind bridge abutments	
e)	Describe in brief classification of maintenance operation.	
Ans:-	Following are the classification of maintenance of road. 1. Routine repair: - These are the regular repair carried out to keep road surface intact for e.g. pot hole repairs, manual reshaping of earthwork, vegetation trimming, repainting of kerb and traffic signs and kilometer stone etc.	
	2. Periodic repair: - Due to the moving traffic and adverse climatic conditions, highways are subjected to wear. Therefore road required periodic maintenance such as resurfacing of wearing course, maintenance of cross drainage works etc.	(1M each)
	 3. Special Repairs: - These repairs are carried put for special type of failure of pavement. It mainly includes improvement of geometrics of highway such as improvement to curves, improvement to visibility, significant repairs to culverts & bridges etc., new safety measures and amenity provisions and repairs/ rehabilitation of major distressed sections. 4. Flood Damages and Emergency Repairs: -It includes repairs or restoration which arises from heavy rains, flooding, snowfall, cyclones, landslides, etc. High priority shall be assigned 	
	to traffic safety and restoration of traffic.	
f) Ans:-	 Define the following i) Kerbs:- The boundaries between the pavement and shoulders or footpaths are known as Kerbs. 	
	ii) Right of way:- The area of land acquired for construction of development of road along its alignment, is known as Right of way.	(2M each)







_			I
		size of dipper.	
d) Ans		Explain the maintenances of bituminous roads. Maintenance of bituminous roads. i) Pot hole repair or patch repair- Potholes or patches can be repaired by using sand premix,	
	d) Ans:-		
		 open grade premix or dense graded premix. It is the rolled or compacted by hand tamping. ii) Sealing of weared surface- various sealing compounds like liquid seal, fog seal, slurry seal are useful to repair cracks, loss of aggregates iii) Surface treatment- It the bituminous surface is weared in large amount, then one or more layers of bituminous mix is applied as surface treatment followed by heavy roller compact iv) Repairing of waves and corrugations- The melted bitumen due to temperature variations 	any four
		results in wavy road. The corrugations may be formed due to iron wheels. It can be removed by cutting and filled	
		by premix with tack coat. v) Repairing of side drains -prior to monsoon, side and vegetation if any for effective carriage of rainwater	
		vi) Resurfacing- When bituminous road is worn out drastically, New bituminous mat layers are provided to renew the surface.	
	e) Ans:-	Explain the working of JCB with suitable line sketch. The working of JCB is explain as under	
		i) Initially JCB is made fixed firmly on ground by lowering rear end stabilizers. As shown in	
		tigure below. ii) Then the deeper arm having excavator bucket attached to its end; is stretched up to target ground surface.	(2M)
		iii) By gear arrangement, it is pressed against ground to excavate material and then bucket is	



turned upward to avoid falling of excavated material.

iv) The filled excavator bucket is raised in closed (folded) position and then boom is turned away from excavation area and material is dropped in truck or dumper by opening face of excavator bucket.

v) Similarly, front bucket is useful to level the ground separately its cutting edge cuts the ground in uniform leveled position.

vi) The cut material is then raised in position and drop away from working area. Thus, JCB works on movement of front and rear bucket powered by cylinder diesel engine.

