



WINTER– 18 EXAMINATION

Subject Name: Highway Engineering

Model Answer

Subject Code: 17602

**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.	Answer	Marking Scheme
Q.1	(A)	<b>Attempt any THREE of the following :</b>	<b>(12)</b>
Q.1	A)a) Ans:-	<b>Enlist any four characteristics of road transport.</b> <b>Characteristics of road transport-</b> 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. 4) Road transport is a important access or way to reach a railway station, an airport, terminal bus stations 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.	01M each (any four)
Q.1	A)b) Ans:-	<b>Describe in brief classification of urban road.</b> The urban roads are classified as: 1) <b>Arterial roads:</b> The streets primarily for through traffic on a continuous route, but with high level of traffic mobility are known as arterial roads. 2) <b>Sub-arterial roads:</b> 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) <b>Collector streets:</b> 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) <b>Local streets:</b> The streets which provide access to abutting streets are known as local streets.	01M each
Q.1	A)c) Ans:-	<b>Enlist any two instruments used &amp; two details to be collected while conducting reconnaissance survey.</b> <b>Two instruments used while conducting reconnaissance survey are:-</b> 1)Prismatic compass 2)Abney level 3)tangent clinometers 4)barometer <b>Following details are collected while conducting reconnaissance survey:</b>	01M each (any two)



Q.1 B)a)  
Ans:

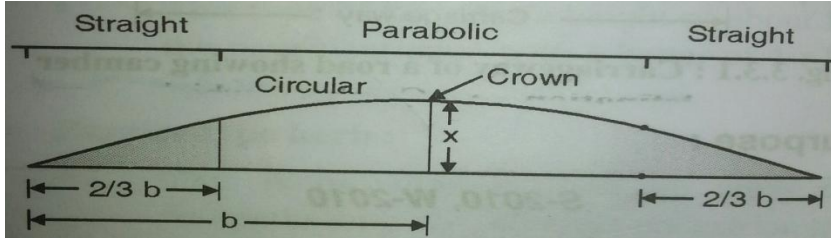
**State IRC recommended values of camber for different types of road surface and enlist shapes of camber with sketch.**

Sr.No	Types of road surface	Camber
1	High type bituminous surfacing and cement concrete surface	1 in 60 to 1 in 50 (1.7 to 2%)
2	Thin bituminous surfacing	1 in 50 to 1 in 40 (2 to 2.5%)
3	Water-bound macadam, gravel road surface	1 in 40 to 1 in 33 (2.5 to 3%)
4	Earth roads, footpaths etc.	1 in 33 to 1 in 25 (3 to 4%)

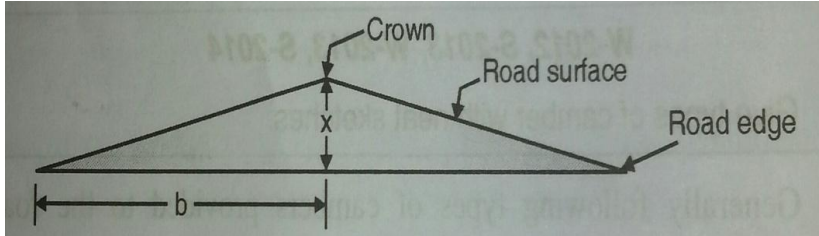
02M

**Shapes of camber:**

1) **Composite camber:**



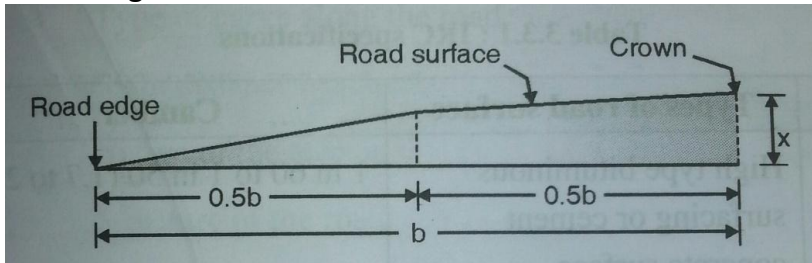
2) **Sloped or straight camber:**



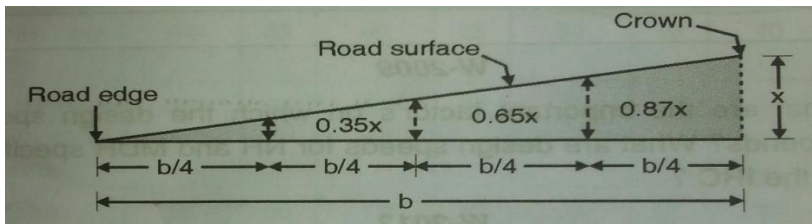
04M

(01M each)

3) **Two straight line camber:**

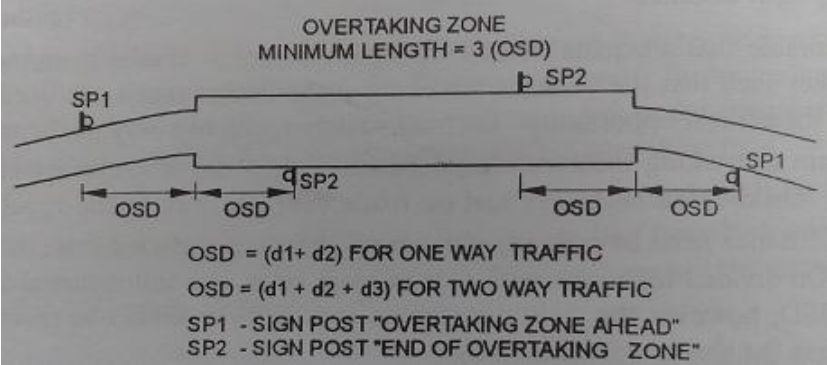


4) **Barrel camber:**



<p>Q.1</p>	<p>B)b) Ans:-</p>	<p><b>Draw typical cross-section of national highway in embankment.</b></p> <p>CROSS-SECTION OF A NATIONAL HIGHWAY (N.H) IN EMBANKMENT</p>	<p>04M for sketch 02M for labeling</p>
<p>Q.2</p>		<p><b>Attempt any FOUR of the following :</b></p>	<p>(16)</p>
<p>Q.2</p>	<p>a) Ans:-</p>	<p><b>Describe in brief objectives of preliminary survey.</b></p> <ol style="list-style-type: none"> <li>1) To survey along the various alignments found after the reconnaissance and to collect all necessary physical information and details of topography, drainage and soil.</li> <li>2) To compare the different proposals in view of the requirements of a good road alignment.</li> <li>3) To estimate the cost of constructing the road including bridges and other construction aspects along each alternative alignment of the road.</li> <li>4) To finalize the best alignment from construction, maintenance and traffic operation point of view.</li> </ol>	<p>01M each</p>
<p>Q.2</p>	<p>b) Ans:-</p>	<p><b>Define alignment. State requirements of ideal alignment.</b></p> <p><b>Alignment:</b> - The position or layout of centre line of the highway or road on the ground is called the alignment.</p> <p><b>Following are the basic requirement of ideal alignment:</b></p> <ol style="list-style-type: none"> <li>a) Short</li> <li>b) Easy</li> <li>c) Safe</li> <li>d) Economical</li> <li>e) Utility</li> <li>f) Natural aspects</li> </ol>	<p>02M 1/2 M each (any four)</p>
<p>Q.2</p>	<p>c) Ans:-</p>	<p><b>Define right of way and enlist any three factors on which right of way depends.</b></p> <p><b>Right of way:</b> - The area of the land acquired for construction and development of a road along its alignment is known as right of way.</p> <p><b>Factors on which right of way depends are:-</b></p> <ol style="list-style-type: none"> <li>1) The category of highway and width of roadway and road margins.</li> <li>2) Height of embankment or depth of cutting.</li> <li>3) Drainage system and its size.</li> <li>4) Sight distance considerations on horizontal curves.</li> <li>5) Reserve land for future widening.</li> </ol>	<p>01M 01M each (any three)</p>



		$= 38.92 + 32.15$ SSD = 71.07 m. for one way traffic. SSD for Two Way traffic on single lane road = 2 x SSD for one way traffic $= 2 \times 71.07 \text{ m}$ $= 142.14 \text{ m}$	01 M  02 M
Q.3	(b) Ans.	<p><b>Draw a neat sketch of overtaking zone with necessary provision of sign post.</b>  <b>Following is the sketch of overtaking zone:</b></p>  <p style="text-align: center;">Figure : Overtaking Zones</p>	02 M  02 M (01 M each sign post)
Q.3	(c) Ans.	<p><b>Discuss special consideration to be adopted while deciding alignment of hill road.</b>  The following are the special considerations to be adopted while deciding alignment of hill road:</p> <p><b>(i) Length of Road:</b> The alignment of hill road should be as short as possible because cost of road kilometerage in hilly area is comparatively very high.</p> <p><b>(ii) Geometrical standards of hill roads:</b> The alignment should have proper geometrical standards such as gradient, curves, radius of curves etc. It should be free from sharp hair-pin bends. The minimum radius of curve for a hill road allowed is 50 m. for a National or State highway. In order to provide proper geometrical standards, the alignment is likely to be changed.</p> <p><b>(iii) Stability:</b> The alignment should be provided along that side of hill which is stable and not very steep. Thus, the alignment of road is to be changed to provide the road on that side of the hill, which is free from landslides.</p> <p><b>(iv) Cutting through rocks:</b> The alignment should avoid cutting through solid rocks because it is a very costly item. Thus, in order to avoid excessive cutting through rocks, the alignment is to be changed.</p> <p><b>(v) Existing saddle or pass:</b> The alignment should cross series of hills through the existing saddle or pass. This may tend to make change in the alignment of the road so as to avoid heavy cost of cutting through rocks.</p>	04 M (01 M each – any four)
Q.3	(d) Ans.	<p><b>Define: (i) bitumen, (ii) Tar. Enlist grades of Bitumen &amp; Tar.</b></p> <p><b>(i) Bitumen:</b> A hydrocarbenous material of either natural or pyrogenous origin, found in gaseous, liquid, semi-solid or solid in state and completely soluble in carbon disulphide (CS<sub>2</sub>) is called “Bitumen”.</p> <p><b>(ii) Tar:</b> The residual product obtained by destructive distillation of organic matter such as coal, oil, wood, etc. in known as TAR.</p> <p><b>(iii) Grades of Bitumen:</b> Following are the grades of Bitumen:  Viscosity Grade-VG            VG10, VG20, VG30 and VG40</p> <p><b>(iv) Grades of Tar:</b> Following are the grades of Tar:  Road Tar- RT                    RT1, RT2, RT3 and RT4</p>	01 M  01 M  01 M  01 M
Q.3	(e) Ans.	<p><b>Define cutback bitumen and enlist types of cutback bitumen.</b>  <b>Cutback:</b>  The solution of a bituminous material (asphalt or road tar) in a volatile solvent is known as cutback.</p>	01 M



		<p><b>Types of cutback:</b> The types of cutbacks are enlisted below: Grade A: It is light and is recommended for use as a primer. Grade B: It is medium and is recommended for surface dressing and resurfacing operations. Grade C: It is heavy and is recommended for premix type road construction.</p>	(01 M each) 03 M
Q.4	(A)	<b>Attempt any THREE of the following:</b>	(12)
Q.4	A)(a)	<p><b>Define:</b></p> <ul style="list-style-type: none"><li>(i) Lead</li><li>(ii) Lift</li><li>(iii) Borrow pit.</li><li>(iv) Spoil bunk</li></ul> <p>(i) <b>Lead:</b> The horizontal distance through which the excavated earth is carried and placed for constructing the bank is called lead.</p> <p>(ii) <b>Lift:</b> The vertical distance through which the excavated earth is lifted for constructing a bank is called lift.</p> <p>(iii) <b>Borrow pit:</b> The pit dug along the alignment of a road for using their material in the construction of road embankment is known as borrow pit.</p> <p>(iv) <b>Spoil bank:</b> The bank constructed from surplus excavated earth on the side of cutting parallel to the alignment of the road is known as spoil bank.</p>	(4 M)  04 M (01 M each)
Q.4	A)(b) Ans.	<p><b>Define traffic control device and enlist various types of traffic control device.</b></p> <p><b>Traffic Control Device:</b> The improvement made and facilities provided to the road users so as to obtain efficient, free and rapid flow of traffic with less number of accidents are known as traffic control devices.</p> <p><b>Types of traffic control device:</b> The types of traffic control devices are enlisted below:</p> <ul style="list-style-type: none"><li>(1) Traffic signs or Road signs.</li><li>(2) Traffic markings or Road markings.</li><li>(3) Traffic signals.</li><li>(4) Traffic islands.</li></ul>	02 M  02 M (All four – 1/2 mark each)
Q.4	A)(c) Ans.	<p><b>Define traffic volume study and state methods for counting traffic.</b></p> <p><b>Traffic Volume Study (TVS):</b> The survey of the number of vehicles and pedestrians crossing a section of road per unit time during any selected period is called “Traffic Volume Study”.</p> <p><b>Methods for counting Traffic:</b> The following are the methods for counting traffic:</p> <ul style="list-style-type: none"><li>(1) <b>Manual Counting:</b> In this method, a field team of enumerators (traffic persons) is deputed to record traffic volume on the prescribed record sheets in a specified period.</li><li>(2) <b>Automatic Recorders:</b> In this method, the total number of vehicles crossing at a road intersection in the desired period is automatically recorded by a mechanical recorder. These recorders are either fixed type or portable type.</li><li>(3) <b>Moving car method:</b> In this method, the number of vehicles met, overtaken and the time taken to travel is noted by the observer moving in a car once against the traffic and second time along with the traffic.</li></ul>	01 M  01 M  01 M  01 M







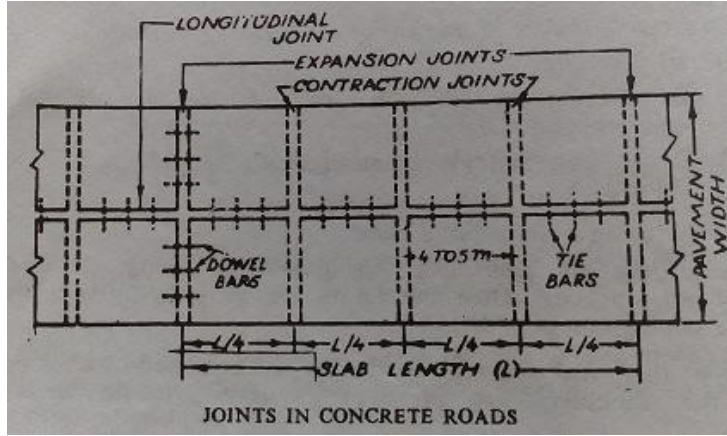
5. **Open to traffic:** After drying, the road is opened to traffic.

Q.4 B)(b)

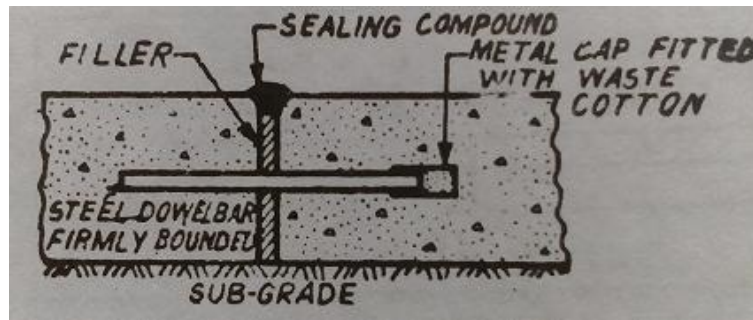
**Draw neat sketch of**  
i) Location of Joints in rigid pavement  
ii) Expansion Joint  
iii) Longitudinal Joint

Ans. The sketches are as below

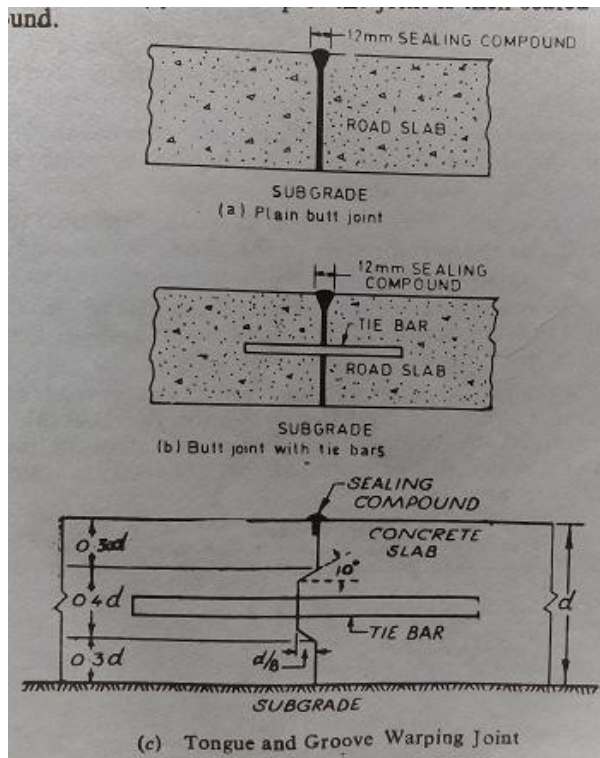
(i) Location of Joints in rigid pavement:-



(ii) Expansion Joint:-



(iii) Longitudinal Joint:-








02 M  
(for neat labeled diagram)

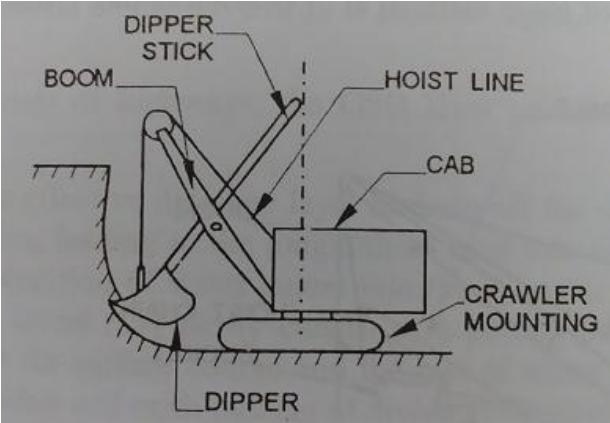
02 M  
(for neat labeled diagram)

02 M  
(for neat labeled diagram)  
(any one figure from (a), (b) and (c))

Q.5 Attempt any FOUR of the following:

(16)

<p>Q.5</p>	<p>(a)</p> <p>Ans.</p>	<p><b>Draw following signs:</b></p> <p><b>i) Give way</b> <b>ii) Speed limit</b> <b>iii) Hair pin bend left</b> <b>iv) No parking</b></p> <p>The following are road signs:</p> <p>(i) Give Way :-</p>  <p>(ii) Speed Limit :-</p>  <p>(iii) Hair pin bend left:-</p>  <p>(iv) No parking :-</p>  <p style="text-align: center;">or</p> 	<p>01 M</p> <p>01 M</p> <p>01 M</p> <p>01 M</p>
<p>Q.5</p>	<p>(b)</p> <p>Ans.</p>	<p><b>Enlist four techniques of prevention and controlling of land slides.</b></p> <p>The land slide cannot prevented due to earthquakes, but landslides due to other causes can be prevented by taking the following measures:</p> <ol style="list-style-type: none"> <li>1) By providing efficient surface and cross drainage.</li> <li>2) By providing sub-surface drains at foot of the hill slope to control seepage flow.</li> <li>3) By providing benching to soil slope.</li> <li>4) By reducing the angle of slope or providing breast walls and retaining walls.</li> <li>5) By constructing buttress at toe of hill slopes.</li> <li>6) By slope treatment to minimize the erosion and to improve the stability of hill slopes. This is done by turfing, stone pitching, cement grouting etc.</li> </ol>	<p>any four (01 M each)</p>

<p>Q.5</p>	<p>(c) Ans.</p>	<p><b>Describe in brief different types of gradient.</b></p> <p><b>(1) Ruling gradient:</b> - 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.</p> <p><b>(2) Limiting gradient:</b> - 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.</p> <p><b>(3) Exceptional gradient:</b> - 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 short lengths not exceeding 100 m at a stretch.</p> <p><b>(4) Average gradient:</b> - 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".</p> <p><b>(5) Floating gradient:</b> - 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".</p> <p><b>(6) Minimum gradient:</b> - The minimum desirable slope essential for effective drainage of rain water from the road surface is called "minimum gradient".</p>	<p>(any four) 01 M each</p>
<p>Q.5</p>	<p>(d) Ans.</p>	<p><b>Describe in brief methodology for Pothole repair in Bitumen road.</b></p> <p>Methodology for Potholes repair in bitumen road is called patching of pothole which is discussed below:</p> <p>For patching pot holes (over 35 mm) depth, these should be cut out square or rectangular in shape up to the affected depth. The holes are then cleaned of all loose aggregate, dust, foreign matter, etc. The internal portion of the holes is then painted with tar or bitumen. After this, usually premixed patching mix is placed in the holes and the surface is rammed or rolled according to the size of the patch. When the pot hole is more than 75 mm deep, the patch should be made in two or three layers and each layer is rammed before placing the next layer. The finished level of the patches is kept slightly above the original level to allow for further compaction under traffic.</p> <p>When the pot holes are only 12 to 25 mm deep, their patching is done simply by cleaning, painting and gritting with dry chippings of 3 to 6 mm size. Their surfacing is then finished according to the adjacent road surface.</p>	<p>04 M</p>
<p>Q.5</p>	<p>(e) Ans.</p>	<p><b>Draw a neat sketch of Power shovel.</b></p> <p>The sketch of power shovel is given below:</p> 	<p>(02 M for diagram 02 M for labeling)</p>



Q.5	(f)	<b>State use of following in highway construction</b> <b>i) grader</b> <b>ii) dragline</b> <b>iii) bulldozer</b> <b>iv) power shovel</b>	
	Ans.	<b>(i) Grader:</b> A grader is mainly used for the following purposes: 1) To give the proper shape to the road subgrade. 2) To construct earth roads quickly. 3) To spread the loose material evenly. <b>(ii) Dragline:</b> Dragline is used to excavate soft earth and deposit in near-by banks or to load into wagons. <b>(iii) Bulldozer:</b> Bulldozer is commonly used for excavating the material and for pushing the same in the forward direction. It is mainly used for pushing and levelling a heap of excavated material. <b>(iv) Power shovel:</b> Power shovels are used for the following purposes: 1) To excavate soils of all types except solid soils. 2) To collect and dump the material at the required place within the reach of dipper stick. 3) To load the excavated soil into dump trucks, conveyor belts or other hauling equipment.	01 M (any two 1/2 M each)  01 M  01 M  01 M (any two 1/2 M each)
Q.6		<b>Attempt any FOUR of the following:</b>	<b>(16)</b>
Q.6	(a)	<b>Enlist different types of roller and state two uses of roller.</b>	
	Ans.	<b>Types of roller: The different types of rollers are as follows:</b> (1) Smooth wheeled roller (also called static roller) (2) Vibratory roller (3) Pneumatic tyred roller (4) Sheep foot roller <b>Uses of roller:</b> The following are the uses of roller. (i) To prepare subgrade of soils for both flexible and rigid pavements. (ii) To compact thick layers of road metal in WBM road construction. (iii) To compress bituminous concentrated layers in roads. (iv) To consolidate the stone chippings, soil and sand. (v) To consolidate the sides of embankments of road. To compact concrete slabs in rigid pavements.	02 M ( 1/2 mark each)  02 M (any four 1/2 mark each)
Q.6	(b)	<b>Enlist the component parts of Hot mix plant.</b>	
	Ans.	Following are the component parts of Hot mix plant: (1) Cold bins. (2) Cold elevator. (3) Aggregate dryer. (4) Dust collector. (5) Hot elevator. (6) Screening Unit. (7) Hot bins. (8) Hot asphalt cements storage unit. (9) Mineral filler storage unit. (10) Mechanical Mixer.	(any eight 1/2 M each)



Q.6	(c) Ans.	<p><b>Describe in brief drainage structure in hill road.</b></p> <p>An adequate and effective drainage is very essential for better service and less maintenance cost of hill roads. The drainage of hill roads consists of the following structure:</p> <ol style="list-style-type: none"><li>1. Surface Drainage</li><li>2. Controlling Seepage flow</li><li>3. Cross drainage</li></ol> <p><b>1) Surface Drainage:</b> In case of hill roads, surface water causes erosion to the road surface and hill sides and may result in landslides or slips. A proper arrangement for drainage of surface water is therefore, importance to prevent erosion and landslides. An efficient network of surface drainage system of a hill road consists of <u>Side drains and Catch water drains or Intercepting drains.</u></p> <p><b>2) Controlling Seepage flow:</b> When the general ground as well as the impervious strata lying underneath are slopping, the seepage flow is likely to exist. If the seepage zone is at a depth less than 0.6 to 0.9 m from the surface of pavement, it is desirable to intercept the seepage flow. For controlling seepage flow, <u>sub-surface drains</u> are provided at foot of the hill slope.</p> <p><b>3) Cross drainage:</b> An efficient cross drainage system is essential for disposing off the surface water collected by catch water drains and side drains across the hill road. It consists in providing cross drainage structure at frequent intervals. An effective cross drainage system prevents side drains from overflowing and flooding the road surface. Cross drainage is provided by constructing <u>Small under drains, Scuppers, Causeways, Culverts and Minor or Major bridges.</u></p>	01 M  01 M  01 M  01 M
Q.6	(d) Ans.	<p><b>Explain necessity of maintenance of road.</b></p> <p>Following are the reasons which highlights the necessity of road maintenance:</p> <ol style="list-style-type: none"><li>(1) Road maintenance is necessary because timely and routine maintenance of the road helps in preventing the accidents.</li><li>(2) Road maintenance is necessary to maintain various component of road like pavement, shoulder, drains, side edges such that it provides the better services to road users.</li><li>(3) Road maintenance is necessary to provide the safe and convenient movements of passengers and goods at all the time.</li><li>(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.</li><li>(5) Road maintenance is necessary to increase the life of the road.</li></ol>	04 M (any four) 01 M Each
Q.6	(e)  Ans.	<p><b>Suggest suitable types of roller for compacting following:</b></p> <ol style="list-style-type: none"><li>i) Clayey soil</li><li>ii) Sandy soil</li><li>iii) Gravel</li><li>iv) Finishing of bitumen road</li></ol> <p>The suitable types of roller for the given soils are as below:</p> <ol style="list-style-type: none"><li>(i) Clayey soil: - Sheep foot roller.</li><li>(ii) Sandy soil: - Smooth wheeled roller or vibratory roller.</li><li>(iii) Gravel: - Smooth wheeled roller or vibratory roller.</li><li>(iv) Finishing of bitumen road: - Pneumatic tyred roller.</li></ol>	01 M for each