



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 the candidate and those in the 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 the model answer.
- 6) In case of some questions credit may be given by judgment 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.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	a)	Attempt any THREE of the following		12
	Ans :	<p>i) State any four characteristics of road transport.</p> <p>Characteristics of road transport :</p> <ol style="list-style-type: none">1. Road transport gives quick and easy transportation of men, machineries, materials etc.2. Road transport serves the agricultural area by transporting of goods.3. It plays a vital role in development of natural resources.4. The road transportation always a key in transportation of medical and educational facilities5. Road transport is a basic need in case of fire and police protections.6. It gives door step connectivity even in case of rural area or villages.7. It promotes development of railways, waterways and airways.	Any four points 1 mark each	4



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	a)	ii) Classify the roads as per Nagpur Road Plan.		
	Ans :	<p>In Nagpur road plan, roads are classified into five categories as per IRC recommendations depending upon priority for development.</p> <ol style="list-style-type: none">1. National Highway (NH) : The roads which runs through length and breadth of the country connecting state capitals, major ports, foreign highways and strategic places across country, which are called as National Highway.2. State Highway (SH) : The roads which joins state capital to important cities within state, are known as State Highway.3. Major District Road (MDR) : The roads which connects market centres and important places in within district, are considered as Major District Road.4. Other District Road : The roads which joins tehsil headquarters, block development headquarters, market centres other than MDR, are known as Other District Road.5. Village Road : The roads which connects the group of villages to higher type of road, are called as Village Road.	Any four points 1 mark each	4
		iii) Define 'Road Alignment'? State factors affecting road alignment.		
	Ans :	<p>Road Alignment : It is the centre line of proposed road marked in plan, which is known as <i>road alignment</i>.</p> <p>Factors affecting road alignment :</p> <ol style="list-style-type: none">1. Unavoidable obstructions : The alignment is required to change in another direction due to avoidable obstructions.2. Connectivity of obligatory points : The selected alignment can be altered for better connectivity to existing roads, important places and high population zone3. Railway or Bridge crossing : The alignment is necessary to divert over railway or bridge crossing at right angle.4. Nature of ground : If ground is more steeper then alignment is required to change towards fairly levelled ground	1 mark	4



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
		<p>5. Type of foundation soil : If foundation soil available in the proposed alignment has less bearing capacity, then alignment is changed through hard subgrade soil.</p> <p>6. Cost of land : If cost of land in particular alignment more, it is necessary to pass it through less costlier land.</p> <p>7. Excessive cutting of rock : The alignment should be such that to avoid excessive cutting of hill rocks coming in alignment.</p> <p>8. Locally available materials : The alignment should be finalised to get continuous and maximum availability of materials required for road construction.</p>		
	Ans :	<p>iv) Enlist the various drawings and plans prepared for road project.</p> <p>The following listed drawings and plans are required for smooth, safe and economic completion of project.</p> <p>1. Key Map, 2. Index Map, 3. Preliminary Survey Plan, 4. Longitudinal Section, 5. Cross Section, 6. Detailed Location Survey Plan, 7. Land Acquisition Plan, 8. Quarry Plan, 9. Detailed Cross-Drainage Plan</p>	Any 8 ½ mark each	4
	Ans :	<p>v) State any four objects of providing super elevation to road pavement.</p> <p>The superlevation is provided to achieve the following objects.</p> <p>1. To avoid skidding off vehicles at sharp horizontal turns. 2. To turn vehicles smoothly even at high speed at curves. 3. To minimise wear and tear of wheels and road surface in contact. 4. To avoid overturning of vehicles at corners by counteracting centrifugal force.</p>	1 mark each	4



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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	b)	Attempt any ONE of the following		06
		i) Calculate the stopping sight distance for two way traffic in a single lane road. The design speed is 68 kmph. Assume reaction time of driver as 2.5 seconds. Coefficient of friction is 0.6. Brake efficiency is 50%.		
	Ans :	Given : V = 68 kmph, t = 2.5 sec., f = 0.6, n = 50 % = 0.5		
		Find : SSD = ?		
		Solution : By formula of Stopping Sight Distance for one way traffic on a single lane road,		
		$SSD = (0.278 V \cdot t) + ((0.278 V)^2 / 2 g \cdot n)$	1	
		$SSD = (0.278 \times 68 \times 2.5) + ((0.278 \times 68)^2 / 2 \times 9.81 \times 0.5)$	1	
		$SSD = 47.26 + 36.42$		
		SSD = 83.68 m	2	6
		Now to calculate SSD for two way traffic on a single lane road		
		$SSD = 2 \times 83.68$	1	
		SSD = 167.36 m	1	
		ii) Calculate the superelevation required for a road of 7.0 m wide on curve of 260 m radius for a permissible speed of 80 kmph. The coefficient of friction is 0.15.		
	Ans :	Given : b = 7.0 m, R = 260 m, V = 80 kmph, f = 0.15		
		Find : e = ?		
		Solution : By formula of superelevation,		
		$e + f = V^2 / (127 \times R)$	2	



Que. No.	Sub. Que.	Model Answers	Marks	Total Mark
2	a)	$e + 0.15 = 80^2 / (127 \times 260)$	1	06
		$e + 0.15 = 0.193$		
		e = 0.0043 for 1 metre width of road	1	
		The superelevation required for 7 m wide road will be,		
		$e = 0.043 \times 7$	1	
		e = 0.301 m or 30.1 cm	1	
		Attempt any FOUR of the following		16
		State different survey operation to be carried out during fixing alignment of road.		
		1. Transferring centreline from map to ground – In this centreline marked in plan is transferred on ground using transit theodolite. While transferring the stakes are fixed at 20m and 50m intervals for hilly and plain terrain respectively. All intersection angles between successive alignments are plotted using theodolite by double reversal method.	1	
		2. Fixing reference points – The reference points on both side of alignment are marked permanently on ground, which helps during construction.	1	
	b)	3. Plotting curves in alignment – The circular or transition curve are plotted using long chord or deflection angle method very accurately. The start and end points are also marked with references.	1	4
		4. Measuring the length of alignment –The total length of alignment as per design is finally checked either by using tape or transit theodolite. It is measured in parts for straight alignments while the chord length for curved alignments.	1	
		What is the importance of following drawing in road project		
		i) Index Map		
		ii) Key Map		



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2	Ans :	i) Index Map – As this map shows general topography of the road construction site, it helps to know overall nature of ground available in the proposed alignment. It helps to decide the actual methodology of construction work.	2	4
		ii) Key Map – As this map gives location of road with respect to other places in the vicinity, it is important to know the cities around the road, existing roads, and important places to be connected. It gives an idea about orientation of road through birds eye view.	2	
	c)	Define ‘Gradient’? Explain types of gradient with IRC recommendation.		
	Ans :	Gradient – It is the rate of rise or fall of ground with respect to horizontal, is known as <i>Gradient</i> OR It is the longitudinal slope provided along the length of road, is known as <i>Gradient</i> .	1	
		Types of gradient –		
		1. Ruling gradient – The gradient which is commonly provide under normal condition is known as ruling gradient.		
		2. Limiting gradient – The maximum gradient provided more than ruling gradient due to topography, is known as limiting gradient.		
		3. Exceptional gradient – The gradient provided in extraordinary situation (very short length road) is known as exceptional gradient.		
		4. Floating gradient – The gradient provided such that vehicle will move with constant speed without application of brakes or power, is known as floating gradient.		
		5. Minimum gradient – The minimum value of gradient provided for removal of water, is known as minimum gradient.		
		6. Average Gradient – The average of both maximum and minimum gradient can be considered as average gradient.		
			Any four 1/2 mark each	4

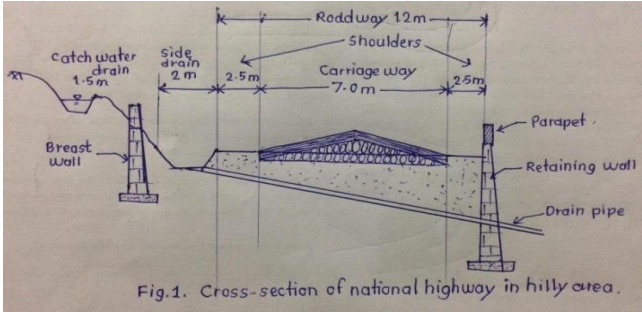


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks																
		<p>IRC Recommendations :</p> <table><tr><th>Nature of area</th><th>Ruling gradient</th><th>Limiting gradient</th><th>Exceptional gradient</th></tr><tr><td>Plain rolling area</td><td>3.3 %</td><td>5 %</td><td>6 %</td></tr><tr><td>Mountainous area</td><td>5 %</td><td>6 %</td><td>7 %</td></tr><tr><td>Steep area</td><td>6 %</td><td>7 %</td><td>8 %</td></tr></table>	Nature of area	Ruling gradient	Limiting gradient	Exceptional gradient	Plain rolling area	3.3 %	5 %	6 %	Mountainous area	5 %	6 %	7 %	Steep area	6 %	7 %	8 %	1	
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Mountainous area	5 %	6 %	7 %																	
Steep area	6 %	7 %	8 %																	
	d)	<p>Define ‘Camber’? State the purposes of camber.</p>																		
	Ans :	<p>Camber – It is the transverse slope provided to width of road is known as camber. OR It is the convexity provided to carriage way is known as <i>camber</i>.</p> <p>Purposes of camber –</p> <ol style="list-style-type: none">1. To drain off rain water from road surface as quickly as possible.2. To regulate traffic into different lanes.3. To improve aesthetic appearance of road.4. To avoid the percolation of water in road sub layers	2																	
			Any two (1 mark each)	4																



Que. No.	Sub. Que.	Model Answers		Marks	Total Marks																																	
	e)	Write difference between flexible and rigid pavement.																																				
	Ans :	<table><tr><th>Sr. No.</th><th>Flexible pavement</th><th>Rigid pavement</th></tr><tr><td>1</td><td>It undergoes the change its shape before is failure</td><td>It does not undergo such change, but fails due to rupture under load</td></tr><tr><td>2</td><td>Temperature variation does not produce stresses</td><td>Temperature variation exerts stresses</td></tr><tr><td>3</td><td>The load is transferred through layer by layer</td><td>The total load is taken by top most wearing surface.</td></tr><tr><td>4</td><td>Construction cost is less</td><td>Initial cost is more</td></tr><tr><td>5</td><td>Maintenance cost is high</td><td>Maintenance cost is low</td></tr><tr><td>6</td><td>It requires strong sub-grade</td><td>It may adjust comparatively weak sub-grade</td></tr><tr><td>7</td><td>Requires less time to construct, hence no delay in traffic</td><td>Requires more time for construction, hence delays traffic</td></tr><tr><td>8</td><td>More tractive resistance</td><td>Less tractive resistance</td></tr><tr><td>9</td><td>Poor visibility at night</td><td>Good visibility at night</td></tr><tr><td>10</td><td>Less durable</td><td>More durable</td></tr></table>	Sr. No.	Flexible pavement	Rigid pavement	1	It undergoes the change its shape before is failure	It does not undergo such change, but fails due to rupture under load	2	Temperature variation does not produce stresses	Temperature variation exerts stresses	3	The load is transferred through layer by layer	The total load is taken by top most wearing surface.	4	Construction cost is less	Initial cost is more	5	Maintenance cost is high	Maintenance cost is low	6	It requires strong sub-grade	It may adjust comparatively weak sub-grade	7	Requires less time to construct, hence no delay in traffic	Requires more time for construction, hence delays traffic	8	More tractive resistance	Less tractive resistance	9	Poor visibility at night	Good visibility at night	10	Less durable	More durable		Any four 1 mark each	4
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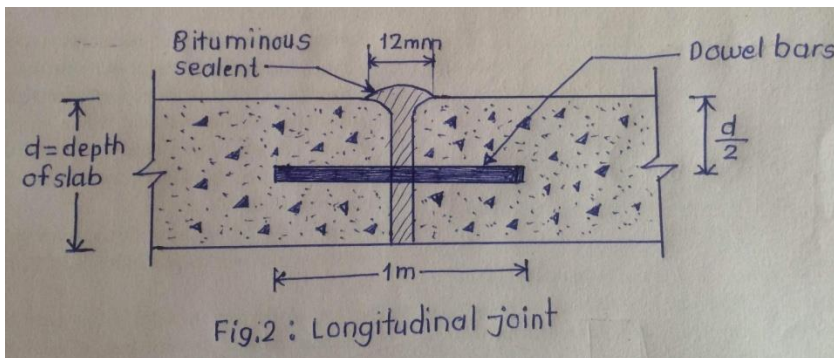


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3	f)	Explain construction procedure of bituminous road.		
	Ans :	<p>The construction procedure of bituminous road is summarised as under</p> <ol style="list-style-type: none"> Preparation of sub-grade – The existing ground is made clean to remove dust and other unwanted particles using ordinary and steel brooms. A thin layer of bitumen is sprayed on this clean surface. Preparation of base course – The hard stone aggregate of specified size is spread approximately along the width of road. These stones are then compacted using vibratory roller of 6-10 tonne capacity. Now a thin layer of bitumen as prime coat is spread manually or mechanically Application of surface dressing courses – The surface dressing includes application of stone chipping and key aggregate, which are binded together using tack coat followed by roller compaction as per design camber on both sides. Laying of wearing course – The wearing surface is laid over one layer of surface course of bituminous mix. The final layer of wearing surface is applied over thin layer of seal coat followed by necessary compaction as per gradient of road. The 30 nos. undulations of maximum 12 mm height are allowed in 30 m length of prepared wearing surface. 	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	4
	a)	Attempt any FOUR of the following		16
	Ans :	<p>Draw a cross section of National Highway in hilly area.</p> 	4	4



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
	b)	What are the factors on which design speed depends?		
	Ans :	<p>The design speed for particular road surface depends on following factors.</p> <ol style="list-style-type: none">1. Type of road, 2. Road condition, 3. Importance of road, 4. Nature and intensity of traffic, 5. Types of curves along the road, 6. Requirement of sight distance, 7. Topography of area	Any four 1 mark each	4
	c)	State and explain factors controlling alignment of hill road.		
	Ans :	<p>The factors controlling the alignment of hill road are as follows.</p> <ol style="list-style-type: none">1. Length of road – It should be less to reduce cost of construction per kilometre.2. Number of curves- If no. of curves is more then it becomes difficulty in construction.3. Excessive cutting of rock- If alignment results in excessive cutting of rocks then it should be diverted to another direction4. Gradient of road- It should be always to lower side to maintain comfortness while driving.5. Landslide prone area- The alignment in hilly area should pass through area of lesser chances of landslides.6. Economy of project- The alignment is selected such that the transportation, construction and maintenance cost will be minimum to achieve overall economy of project.	Any four 1 mark each	4
	d)	What is soil stabilised road. State the necessity of soil stabilisation.		
	Ans :	<p>Soil stabilised road – The road which is constructed by using one or two layers of ordinary or stabilised soil is known as <i>soil stabilised road</i>.</p> <p>Necessity of soil stabilisation :</p> <ol style="list-style-type: none">1. Due to soil stabilisation, the shear strength of road soil increases, which increases its load carrying capacity.	1	4



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
		<p>2. It enhances the stability of slopes in hill roads, side embankments of road etc.</p> <p>3. It improves the capacity of absorption of vibrations due to dynamic loads i.e. airfield pavements.</p> <p>4. It increases the density of soil by reducing voids, which ultimately reduces chances of defects in road.</p> <p>5. In reduces wear and tear to road, which shows increased durability of road surface.</p> <p>6. Soil stabilisation keeps road in working condition for longer period, which indicates lesser maintenance expenses.</p>	Any three 1 mark each	
	e)	<p>Explain with neat sketch the various types of longitudinal joints in pavement.</p>		
	Ans :	<p>Longitudinal Joints in pavement – The joints provided in longitudinal direction of road in between two strips of road is known as <i>longitudinal joints in pavement</i>.</p> <p>It is provided when width of road is more than 4.5 m. It binds two slabs using dowel bars of 20 cm dia. And 30-50 cm length. The dowel bars are placed perpendicular to alignment of road and parallel to ground. These bars act as load transfer device. The joint is then filled with bituminous sealant as shown in the sketch below.</p>	1	
			1	4
			2	



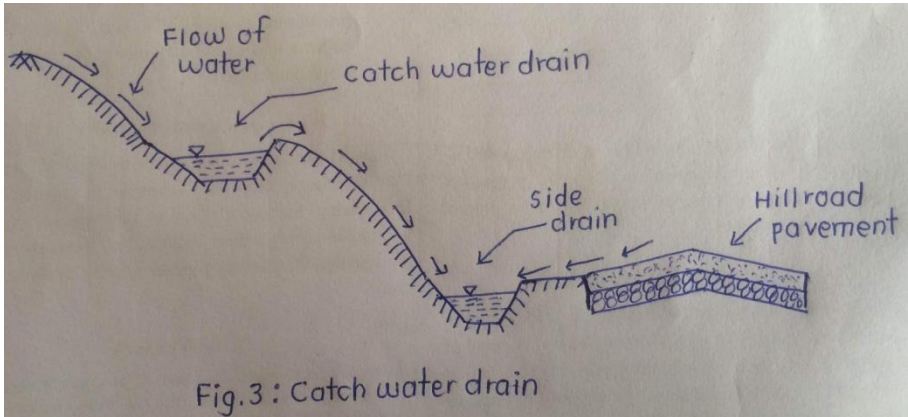
Model Solution : Summer 2016

Subject & Code: Highway Engineering (17602)

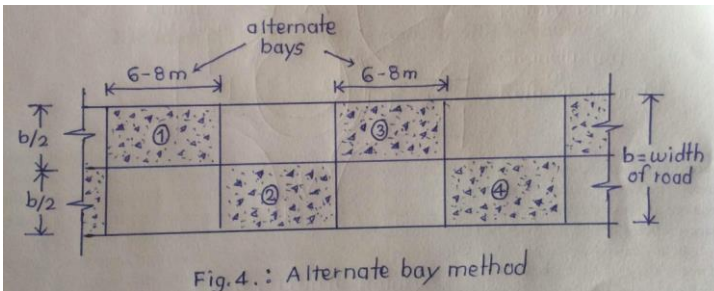
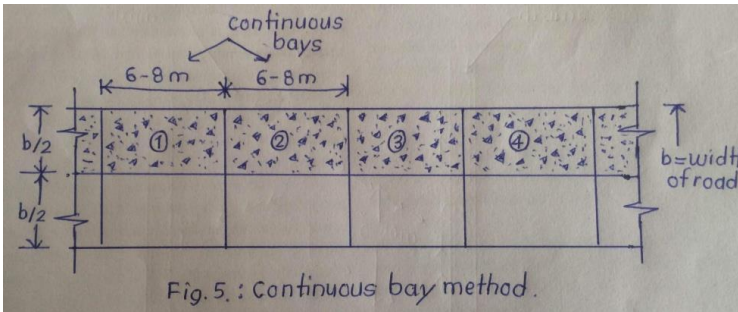
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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4	a)	Attempt any THREE of the following		12
		i) What is prime coat? What purposes does it serve?		
	Ans :	Prime coat – It is a thin layer of liquid bitumen spread upon untreated gravel surface, is known as <i>prime coat</i> .	1	
		Purpose of prime coat – It serves following purposes.		4
		1. It is spread for good adhesion between base coarse and levelling coarse.	3	
		2. It binds loose aggregate in the base course.		
		3. It also plugs capillary voids in the foundation course.		
		ii) Define ‘Traffic density’ and ‘Traffic capacity’.		
		Traffic density – It is the number of vehicles occupied in unit length (usually per kilometre) of road at a given instant, is known as <i>traffic density</i> .	2	
		Traffic capacity – It is the maximum number of vehicles accommodating in a lane and passing a point in unit time (usually per hour), is known as <i>traffic capacity</i> .	2	4
		iii) Explain the methods of traffic volume study.		
	Ans :	As traffic volume study is counting number of vehicles, there are three methods of traffic volume study		
		1. Manual counting method – In this method, a team of recorders observes the traffic flow at road intersection and counts manually all the types of vehicles. The counted numbers are then note down in enumerators form.This method is cumbersome but most reliable for categorised analysis of vehicles. It can be done for 8, 12, 18 and 24 hours duration.	Any two 2 marks each	4
		2. Automatic counting method – In this method, automatic recorders are fixed in road pavement. The impulses caused to movement of vehicles get recorded the numbers automatically. Sometimes an electrical recording is done which works on		

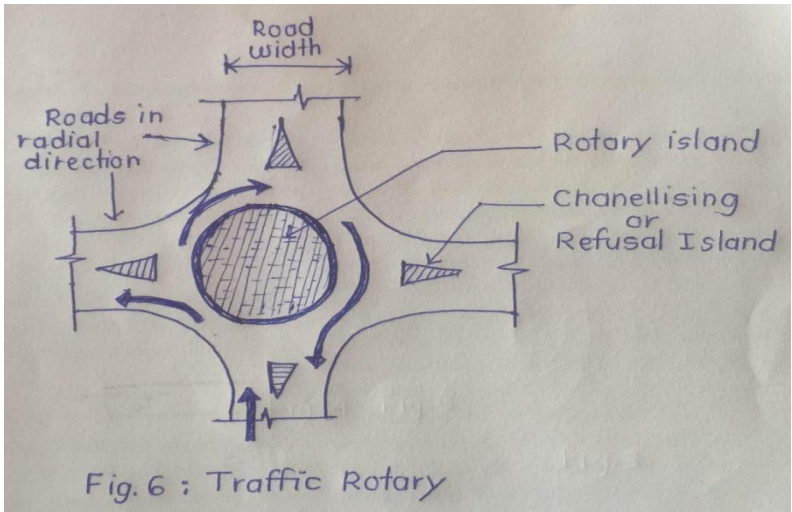


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
		<p>closing electrical circuit due to passage of vehicle. When pneumatic method is used, the counter may activate due to switching air switch. This method is advantageous for continuous recording for longer duration easily. But it does not give classified data of vehicles.</p> <p>3. Moving car method – In this method, an observer in moving car records no. of vehicles met and overtaken. It also counts the time required to travel for both along and against traffic flow. The traffic volume is then calculated by formula, $V = (x + y) / (t_a + t_w)$; where, x = number of vehicles met when moving against desired direction in t_a minutes and y = number of vehicles overtaken while moving along with the traffic in the direction in t_w minutes. The accuracy of this method depends upon the number of tests conducted.</p> <p>iv) Draw a neat sketch of catch water drain.</p>		
	Ans :		4	4
	b)	<p>Attempt any ONE of the following</p> <p>i) State the methods of construction of cement concrete road. Explain any one.</p>		06
	Ans :	<p>Methods of construction of cement concrete road –</p> <ol style="list-style-type: none"> 1. Alternate bay method 2. Continuous bay method 	2	



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
		<p>Explanation :</p> <p>1. Alternate bay method – In this method, the cement concrete mixture is placed in alternate bays of 6-8 m length as shown in figure below. The remaining part of concrete pavement is placed after sufficient hardening of initially casted bays. The already casted bays may be used as working platform. But water may get accumulated in unconstructed bays during rainy season. The joints between bays can be easily constructed. But construction work in this method covers full width road, hence traffic is required to divert completely.</p>  <p>2. Continuous bay method – In this method, the concrete mixture is placed in continuous bays with no. of transverse joints as shown in figure below. The half width of road is constructed with continuous bays of 6-8 m each. After hardening of one side strip, remaining half width is casted with same technique. As half width is casted, no traffic delay takes place. Moreover it gives speedy construction. The only drawback is that more concrete is required at a time for construction. The extra care is required to be taken for longitudinal joints.</p> 	<p><i>Any one</i></p> <p>explanation 2 marks & sketch 2 marks</p>	<p>6</p>



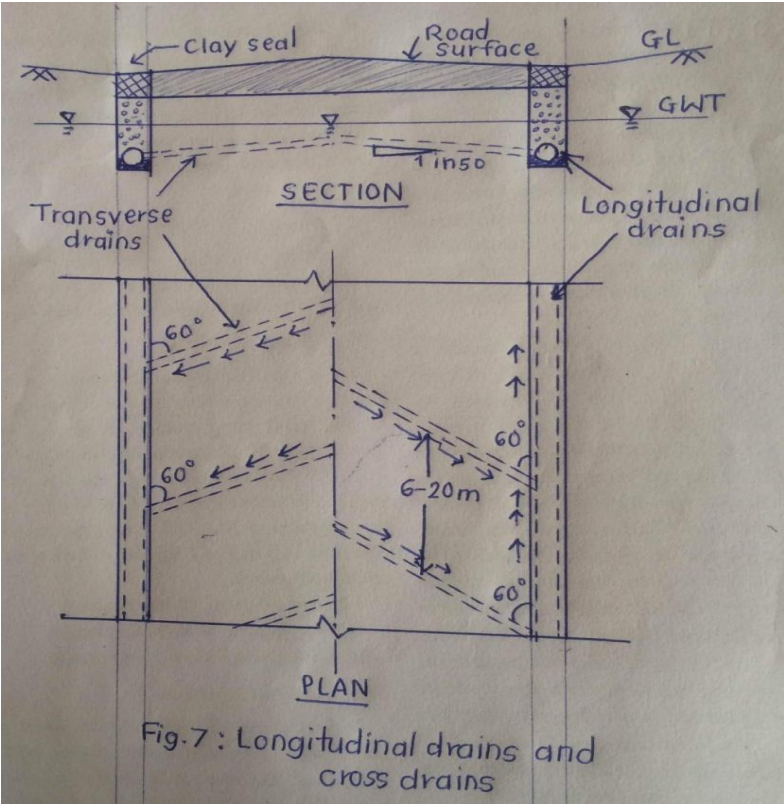
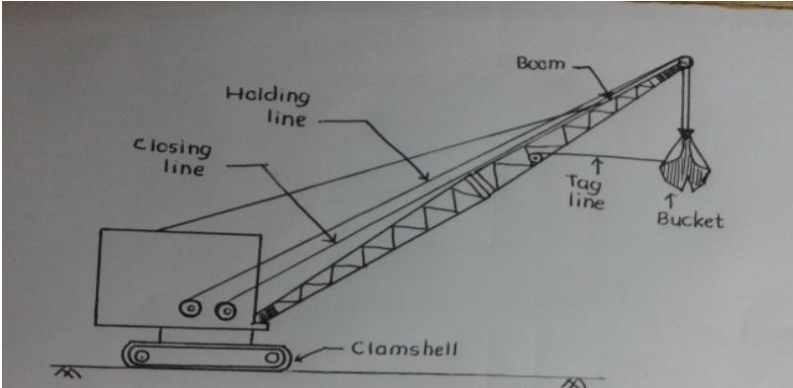
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5		ii) Define the terms : Borrow pit, Spoil banks, Lead.		
	Ans :	Definitions of terms related to earth road are as under		
		1. Borrow pit : The trench excavated along the alignment of road for the use of excavated soil for road construction, is known as <i>Borrow pit</i> .	2	6
		2. Spoil banks : The storage or stock of surplus soil excavated for further use, is known as <i>Spoil banks</i> .	2	
		3. Lead : It is the horizontal distance upto which excavated material is transported for dumping, for which extra payment is not required to pay to the contractor, such min. Distance is known as <i>Lead</i> .	2	
	a)	Attempt any FOUR of the following		16
		What is traffic rotary? Explain with neat sketch.		
	Ans :	Traffic rotary – The island constructed at intersection for complete movement in clockwise direction, is known as <i>Traffic rotary</i> . It is constructed for following objectives.	1	
		<ol style="list-style-type: none"> To eliminate the necessity of stopping the crossing stream of vehicles To reduce area or points of conflict at congested intersections. 		
			2	4



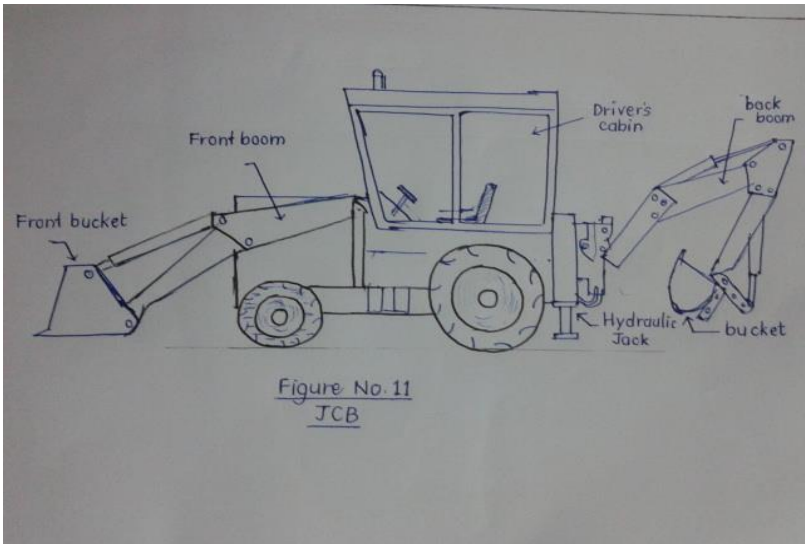
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
		<p>The island is so constructed that vehicles may rotate in a particular lane and then may divert in radial direction from rotary as shown in figure 6. As vehicles moves clockwise direction, direct conflicts are removed. The refusal island gives two way movement of vehicles around the rotary. Depending upon the shape of island, traffic rotary may be circular, elliptical, square or rectangular type.</p>	1	
	b)	State the various causes of Land Slide.		
	Ans :	<p>Causes of land slide – The causes of landslides are enlisted as follows.</p> <ol style="list-style-type: none">1. Increase in water content of soil during rainy season.2. Undermining caused by erosion or excavation.3. Vibrations and shocks caused by blasting or earthquakes.4. Hair cracking due to alternate swelling and shrinkage of the soil mass.5. Formation of faults in bedding planes of the strata due to vibrations6. Due to seepage pressure of percolating ground water.7. Due to failure of breast wall constructed for hill roads.	Any four 1 mark each	4
	c)	Define Kerb, Right of way.		
	Ans :	<p>Kerb – It is the boundary between two pavement lanes or a pavement and a shoulder, is known as <i>Kerb</i>.</p> <p>Right of way – The area of land acquired for construction of development of road along its alignment, is known as <i>Right of way</i> or <i>Permanent land width</i>.</p>	2 2	4



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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	d)	<p>Draw the neat sketch (plan and section) of longitudinal drain and cross drain.</p> <p>Ans :</p>  <p>Fig.7 : Longitudinal drains and cross drains</p>	2	4
	e)	<p>Draw a neat sketch of Dragline.</p>  <p>Figure No.10 Drag line</p>	2	4



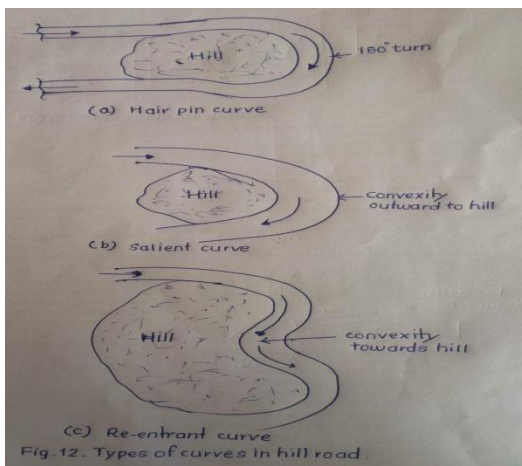
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6	f)	Draw a neat line sketch of JCB and show components.	4	4
	Ans :	 <p>Figure No.11 JCB</p>		
6	a)	Attempt any FOUR of the following State the component parts of hot mix plant.	Any eight 1/2 marks each	4
	Ans :	<p>Component parts of Hot Mix Plant – The major parts of hot mix bitumen plant is as under.</p> <ol style="list-style-type: none"> 1. Cold bins – For storage of cold aggregates. 2. Cold elevator – For conveying the cold aggregate in dryer. 3. Aggregate dryer – For drying aggregate by heating rotary drum. 4. Dust collector – For collecting dust after drying of aggregate. 5. Hot elevator – For conveying the hot aggregate in screening unit. 6. Screening Unit – For removing unwanted particles from aggregate. 7. Hot bins – For storage of hot aggregate. 8. Hot asphalt cements storage unit – For storage of bituminous materials. 9. Mineral filler storage unit – For storage of mineral additives. 10. Mechanical Mixer –For mixing bituminous mix. 		



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 (Autonomous)
 (ISO/IEC - 27001 - 2005 Certified)
Model Solution : Summer 2016

Subject & Code: Highway Engineering (17602)

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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
	b)	State the uses of compacting equipment.		
	Ans :	<p>The uses of compacting equipments in road construction are as follows.</p> <ol style="list-style-type: none"> 1. To prepare subgrade layer of soils for both flexible and rigid pavements. 2. To compact thick layers of road metal in WBM road construction. 3. To compress bituminous concentrated layers in roads. 4. To consolidate the stone chippings, soil, sand and stone chippings. 5. To consolidate the side embankments of road. 6. To compact concrete slabs in rigid pavements. 7. To knead the boulders in case of road in embankments. 	Any four 1 mark each	4
	c)	What are the various types of curves provided in hill road? Draw sketch of any one type.		
	Ans :	<p>Types of curves in hill road – The following curves are provided in hill road construction.</p> <ol style="list-style-type: none"> 1. Hair pin bend curve 2. Re-entrant curve 3. Salient curve 	Any two 2 marks	4
		 <p style="text-align: center;">Fig. 12. Types of curves in hill road.</p>	Any one type 2 marks	



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	d)	Explain surface drainage system in urban roads.		
	Ans :	Surface drainage system in urban roads – In case of urban roads, surface drainage is more necessary to avoid blockage of sewers and pipelines if any. The camber and gradients provided helps to carry surface water away from road surface, but it becomes important to carry it far away from road as quickly as possible. Therefore for effective drainage of water form surface sources, following two drain structures should be constructed.	1	
		1. Catch water drain – These are constructed along steep slope of hill to catch surface runoff coming from hill top as shown in figure. These avoid part of rainfall coming on road surface. It grabs the storm water and discharge to another location away from road. It runs parallel to road alignment on its either sides.	1	4
		2. Side drain or side gutter –These are excavated at the end of berms purposefully to collect water flowing from road surface to it as shown in figure. It also runs parallel to road alignment for effective discharge of surface storm water. It is necessary to provide wire mesh to avoid entry of unwanted materials and further blockage. The collected water in side gutters is carried through nallah and river ultimately.	1	
		Thus surface drainage system helps to keep the road surface in dry condition. It avoids direct entry of storm water in road pavement in urban area.	1	
	e)	Enlist eight types of equipments used for excavation work.		
	Ans :	Types of excavating equipments – The following types of excavating equipments are used for road construction.		
		1. Bulldozers, 2. Scrappers 3. Graders, 4. Power Shovels, 5. JCB 6. Dredgers 7. Trenchers or Ditchers, 8. Rippers, 9. Skimmers, 10. Drag lines, 11. Clam shell, 12. Hoe, 13. Tractors	Any eight ½ marks each	4