Model Solution : Winter 2016

Subject: Highway Engineering (17602) **Subject Code- 17602**

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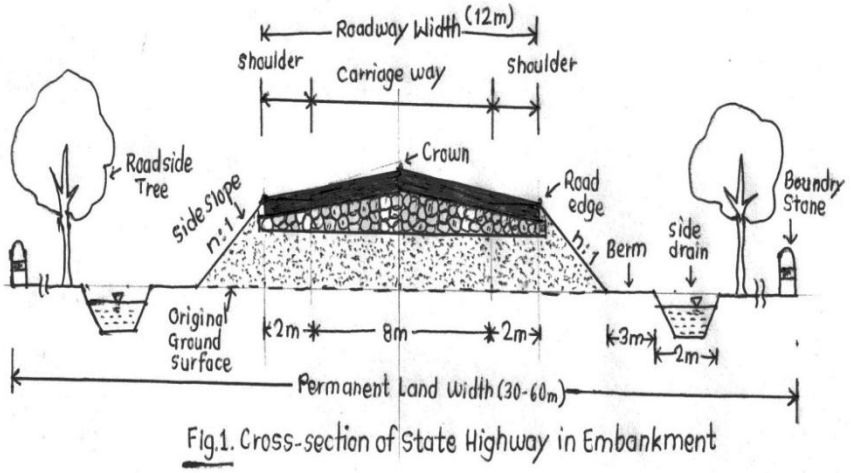
Important Instructions to examiners:

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) i) Ans :**	**Attempt any THREE of the following:** **State the importance of Road Development Plan.** The road development plans of twenty years are important for the following : a) To increase the kilometerage of major roads and minor roads across the country. b) To bring every village in a developed and semi developed agricultural area. c) To construct and maintain several types of roads to accelerate the pace of economic progress. d) To increase the pavement thickness of existing roads for rapidly increasing vehicles. e) To access traffic problems and execute remedial measures like road diversion, subway, flyover etc. f) To increase social development through connectivity between rural and urban areas. g) To increase industrial development through transportation of goods, fisheries, dairy, products etc.	**1 mark each (Any four)**	**12** **4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	ii)	**State the characteristics of road transport.**		
	Ans :	**Characteristics of road transport :** 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 facilities 5. 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.	**1 mark each (Any four)**	**4**
	iii)	**State purpose of different types of engineering survey for road project.**		
	Ans :	**Different types of engineering survey for road project are-** a) **Desk study –** To study the information and statistical data of existing roads in proposed are using various drawings available. b) **Reconnaissance survey –**To know general characteristics of proposed area and to finalize three most feasible routes or alignments of road. c) **Preliminary survey –**To examine detail characteristics of proposed alignments and to finalize one most feasible alignment based on detailed survey. d) **Location survey –** To locate or fix the alignment of proposed road on ground.	**1 mark each**	**4**
	iv)	**State the contents of the drawings required for road project**		
	Ans :	The contents of various drawings prepared for a highway project are as follows: **1)Key map:** The map which shows the proposed road, existing roads and important places to be connected is known as key map. The size of map generally should exceed 240 x 330mm (A4). The size of this map is chosen depending on the area to be covered. **2) Index map:** The locality map also called key map drawn to a scale 1:250,000. It shows the location of the road with respect to important towns, industrial centers, etc. In short it provides bird eye view of the project.		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	**iv)**	**3) Preliminary survey plan:** These plans show the details of the various alternate alignments and other information collected during preliminary survey. The size of these plans varies from 240x330mm to 880x1230mm and their scale may also be varied from 10cm=1km to 20cm=1km. **4) Detail location survey plan and longitudinal section**: The plan should be drawn at the top and longitudinal section at the bottom. The general scale for horizontal length is 1:2500 and for vertical distances 1:250 naturally for hilly stretches this scale could be changed. **5) Detail cross section of road:** The cross section should be drawn serially along the continuous chainage. This cross section should show existing road level/ground level, and the proposed road level, area of cut and fill involved and type and thickness of different pavement courses **6) Land acquisition plans:** These maps are required for land acquisition proceedings. Generally they are prepared on existing village maps, or settlement maps giving the details of property and their survey number so that the land acquisition proceedings could be smooth. **7) Drawings of cross drainage and masonry structures:** A separate drawing is given when there is typical and different design for the cross drainage structure. For small cross drainage work, standard designs are adopted.	**1 mark each (Any four)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	v)	**Define and state values of following terms with IRC standard for plain areas.** **1) Camber 2)Super-elevation**		
	Ans :	**1.Camber –** It is the transverse slope provide to the carriage way. OR It is the surface joining crown point to the road edge point.	**1**	
		IRC values of camber for different roads in plain area: 1)Earth road : 3 to 4 % 2)Water Bound Macadam road : 2.5 to 3 % 3)Bituminous road : 2 to 3 % 4)Cement concrete road : up to 2 %	**1**	**4**
		2.Super-elevation- The inward inclination provided to the cross-section of road at sharp curve, so that outer edge is raised with respective inner edge of road, is called as super elevation.	**1**	
		IRC value for plain area -7 %	**1**	
	b)	**Attempt any ONE of the following:**		**6**
	i)	**Draw a cross-section of state highway in embankment and label all its components and give approximate values of the same.**		
	Ans :	 Fig.1. Cross-section of State Highway in Embankment **(Note- 3 marks for sketch and 3 marks for labeling)**	**6**	**6**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	**ii)**	**Design a super-elevation for a National Highway with design speed 80 Kmph and horizontal curve of radius 150 m. Consider co-efficient of friction f = 0.15.**		
	Ans :	**By formula of super-elevation**		
		$e + f = V^2/(127 \times R)$	**2**	
		$e + 0.15 = 80^2/(127 \times 150)$		
		$e + 0.15 = 0.335$		**6**
		e = 0.185 for 1 meter carriage way width of road	**2**	
		The super elevation required for 7 m wide road		
		$e = 0.185 \times 7$		
		= 1.295 m or 129.5 cm	**2**	
2		**Attempt any FOUR of the following:**		**16**
	a)	**State four factors affecting road alignment.**		
	Ans :	**Factors affecting alignment of roads:**		
		1.Need of traffic 2.Purpose and class of road 3.Obligatory points 4.Curve 5.Gradient 6.Sight distance 7.Number of CD works 8.Obstruction 9.Earthwork 10.Availability of labour and material	**1 mark each (Any four)**	**4**
	b)	**Describe procedure to fix alignment of road.**		
	Ans :	**Procedure for fixing alignment of road-** **1. Transferring centerline from map to ground –** In this centerline 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. **2.Fixing reference points –** The reference points on both side of alignment are marked permanently on ground, which helps during construction. **3.Plotting curves in alignment –** The circular or transition curve are plotted using long chord or	**1 mark each**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2	**b)**	deflection angle method very accurately. The start and end points are also marked with references. **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.		
	c) Ans:	**Explain term "Design speed".** **Design Speed**: The maximum safe speed of vehicle assumed for geometrical design of highway of know as Design Speed. The overall geometric design of any road depends on design speed. The following factors affects design speed. a) **Class and condition of road surface_-** If road is of higher class and good condition, design speed is kept more and vice versa. b) **Traffic characteristics** - If traffic intensity is more in a particular locality, design speed should be minimum. c) **Sight distance requirement** – If sight distance requires is more, design speed is kept lesser. d) **Nature of terrain** - If the road has more steeper gradient on particular terrain, design speed should be lesser. e) **Type of road curve –** If alignment has more number of sharp curves, overall design speed should be lesser. f) **Type of road sub-structure** – If pavement is flexible type with weak sub layers, design speed will be low for it.	**1** **3**	**4**
	d) Ans:	**Explain the significance of gradient in road alignment.** The gradients to a road are of prime importance as it plays significant role as explained follows: i) Gradient are responsible to decide equal cutting and filling of earthwork and hence to reduce material cost of road project. ii) Gradient are beneficial to connect roads at different levels. iii) Gradients plays a vital role for effective drainage of rainwater from road surface. iv) Gradients are helpful to reduce maintenance cost of road	**1 mark each (Any four)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2		surface by avoiding wear and tear of road. v) Gradients are useful to increase or decrease the design speed as per requirement.		
	e) Ans :	**State methods of soil stabilization and explain any one.** **Methods of soil stabilization are -** i. Mechanical soil stabilization ii. Soil-lime stabilization iii. Soil-cement stabilization iv. Soil-bitumen stabilization v. Stabilization by beating vi. Stabilization by grouting vii. Stabilization by freezing viii. Stabilization by chemicals.	**2 marks (Any four)**	**4**
		<u>Mechanical soil stabilization –</u> i. Excavation of subgrade soil should be done by JCB. ii. Pulverization should be done to form fine particles. iii. A specific size of aggregate as per IRC are added in soil to improve soil particles. iv. Then suitable compaction should be done using heavy compaction roller followed by curing. v. After alternate curing and compaction for minimum 7 days, The road is said to be stabilized **(Note-Any other relevant method should be considered)**	**2 marks**	
	f) Ans :	**Describe procedure of cement concrete pavement construction.** **<u>Procedure of cement concrete pavement construction</u>** i. **<u>Preparation of subgrade</u>-** The corrugations are made on subsurface inclined to centerline of road followed by sprinkled on this subgrade for 6-20 hr. before placing concrete ii. **<u>Provision of sub base</u>-** The well graded gravel of specified size is laid over compacted subgrade to improve bearing capacity, It is property compacted as per gradient and camber required. iii. **<u>Erection of formwork</u> –**The channel section are provided up to width of road. The height of sections is kept exactly equal to depth of concrete slab required. **iv.** **<u>Placing and compaction of concrete –</u>** The concrete mixture is placed using RMC vehicles up to height slightly more than	**4**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2	**f)**	slab thickness. The concrete can be placed by alternate or continuous bay method. It is then compacted using screed board or vibrating machine. The wooded or steel float is used to make leveling of concrete. v. **Brooming of concrete surface –** The leveled surface is then broomed using steel broom or steel brush to increase skid resistance of surface. vi. **Curing of concrete road-** The prepared concrete slab is allowed to dry for 24hr and then curing is done by ponding method for 7 days continually. Then after sufficient curing, road is allowed for traffic.		
3.	**a)**	**Attempt any FOUR of the following:** **Calculate the stopping sight distance for one way road having design speed 60 kmph and breaking efficiency of vehicle 75 %** **Given:**		**16**
	Ans :	V = 60 kmph, f = 75% = 0.75 **Find,** SSD=? By formula of stopping sight distance for one way traffic on a single lane road. $SSD = (0.278\ v.t) + (V^2/254.f)$ Assume reaction time of driver, t = 2.5sec $SSD = (0.278X60X25) + (60^2/254X0.5)$ $= 41.7+28.34$ **SSD = 70.04 m**	**2** **1** **1**	**4**
	b)	**Calculated the overtaking sight distance for two lane one way traffic road with design speed 80 kmph. The rate of acceleration of fast moving vehicle is 0.75 $m/s^{2.}$ the speed of slow moving vehicle is 40kmph.**		
	Ans :	**Given :** V_1 = 80 kmph V_2 =40 kmph a = 0.75 m/s^2 **Find** OSD =? By formula of overtaking sight distance for one way traffic on two lane road,		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3	**b)**	OSD = D_{1+} D_{2+} D_3 D_1=distance travelled during reaction time $D_1 = V_b.t$ Where V_0=design speed of overtaken vehicle B $V_b = V_2/3.6$ $= 40/3.6$ V_b =11.1 m/s D_1=11.1 X 2 = **22.2m** Now, D_2 =distance travelled during overtaking time $D_2 = V_b.T + 2S$ $S = 0.7V_b + 6$ $= 0.7 X 11.1 + 6 = 13.8m$ T = 4.5 D_2= (11.1 X 8.57)+(2 X 13.8) **= 122.72m** Now, D_3= distance travelled by opposite vehicle $D_3 = V.T$ Where V = Design speed of overtaking vehicle A $V = V_1/3.6$ $= 80/3.6$ $= 22.22$ m/s D_3 = 22.22 X 8.57 **= 190.42m** OSD = 22.22+122.72+190.42 **= 335.34m**	**1** **1** **1** **1** **1**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3	c) Ans.	**Explain the Difference between Hill road and Roads in plain.**	**1 mark each (Any Four)**	**4**

Hill Road	**Roads in plain**
The roads which are constructed by cutting hill rocks is known as hill roads	The road which are construed on fairly leveled ground without cutting (but with embankment) is known as road in Palin
Catch water drain and side drains are provided on hill top side only for drainage.	Side gutters are provide on both sides of alignment for effective drainage
Retaining wall with parapet is necessary for its stability.	Side slope or side embankment with shoulder are required for its stability
The types of hill roads curves are hair pin bend curve , salient curve and re- entrant curve	The types of curves for roads in plain area are horizontal and vertical curves
Construction of hill roads tedious and required more time	Construction of roads a plain is comparatively simple and quick
More maintenance is required for hill roads throughout the year	Periodic maintenance is sufficient for road in plain areas
Hill roads may pass through tunnels and hence required special cutting machines	Ordinary machines are sufficient to complete road construction
Landslides, settlements, cracks are the common problem in hill roads	No such common problems occurred in well-constructed plane roads

d)

Ans :

Explain the procedure of penetration Macadam for Bituminous Road Construction

The construction procedure of bituminous road is summarized as under

1. **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

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3	**d)**	on this clean surface. 2. **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 3. **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. 4. **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.	**4**	**4**
	e) **Ans :**	**Explain the procedure of WBM road construction** **Procedure of WBM road construction is -** i. **Preparation of Subgrade-** The natural ground is corrugate with JCB at 45˚ to the alignment of road. It is then competed by sprinkling water on it. ii. **Preparation of base Course-** The stone aggregates of specified size as per IRC are land over course sand followed by roller compaction of 6-10 tonnes capacity. The compaction should be done from road edge towards crown by overlapping compaction width. iii. **Application of screenings** – The Screening material in the form of stone chips or smaller size aggregates is spread evenly using steel brooms. These screenings is applied to fill void of stone aggregate. iv. **Application of filler material-** the soft murum is spread on the screening in one or two layers. It is then competed by sprinkling water on it. After certain days of casing road is opened out for traffic.	**1 mark each**	**4**

Model Solution : Winter 2016

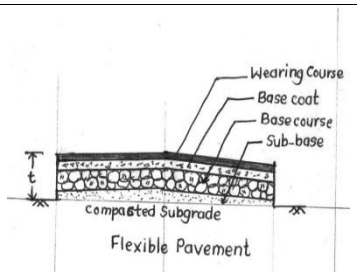
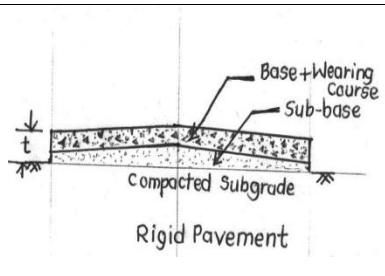
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4	**a)**	**Attempt any THREE of the following:**		**12**
	i)	**State objectives of pavement**		
	Ans :	**objective of pavement -** 1. To carry superimposed moving or dynamic loads of vehicles 2. To distribute the vehicular load in different sub layers without exceeding bearing capacity of subgrade soil 3. To absorb the shocks and vibrations exerted by dynamic loads 4. To dispose off rainwater away from road surface by avoiding entry of water in road substructure. 5. To avoid ground water table rise in if for keeping road in dry condition 6. To provide the passage of actual movement of vehicle on it.	**1 mark each (Any Four)**	**4**
	ii)	**Define following terms** **1) PCU 2) Traffic capacity**		
	Ans :	**1. PCU :-** Practically, the passenger car is considered as standard vehicle to convert the other vehicle classes is known as "Passenger Car Unit".	**2**	**4**
		2.Traffic Density:- It is the number of vehicles occupying a unit length of a road way at a given instant, usually expressed as vehicles per kilometre. is known as traffic density.	**2**	
	iii)	**State traffic characteristics**		
	Ans :	1.Traffic characteristics or Road user characteristics 1. Vision of road user 2. Hearing ability of road user 3. Strength of road 4. Psychological condition of driver	**2**	
		2. Vehicular characteristics 1. Height of drivers eye level 2. Length of vehicles 3. Gross weight of vehicles 4. Breaking distance of vehicle	**2**	**4**

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>4</td><td>iv)
Ans :</td><td>State necessity of maintenance of roads
Necessity of maintenance of roads -
1. To avoid various defects occurring in roads i.e. Potholes ,cracks etc.
2. To minimize road accidents takes place due to road defects
3. To help in safe and smooth vehicular movements on road surface
4. To keep road features in good conditions on as per geometric design suggested by IRC
5. To increase ultimate life of road structure.</td><td>1 mark each (Any four)</td><td>4</td></tr>
<tr><td></td><td>b)
i)

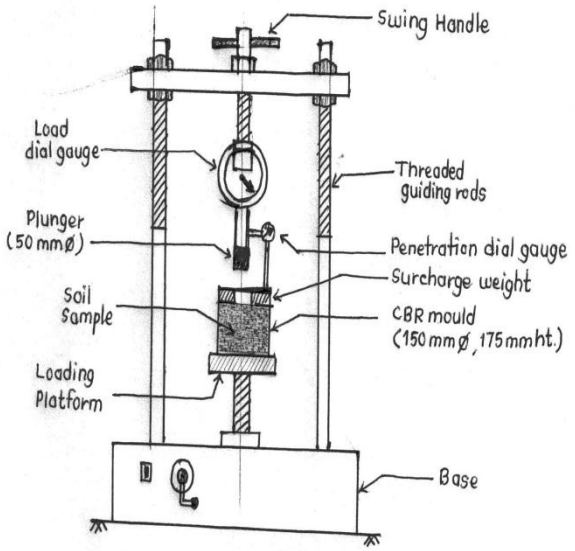
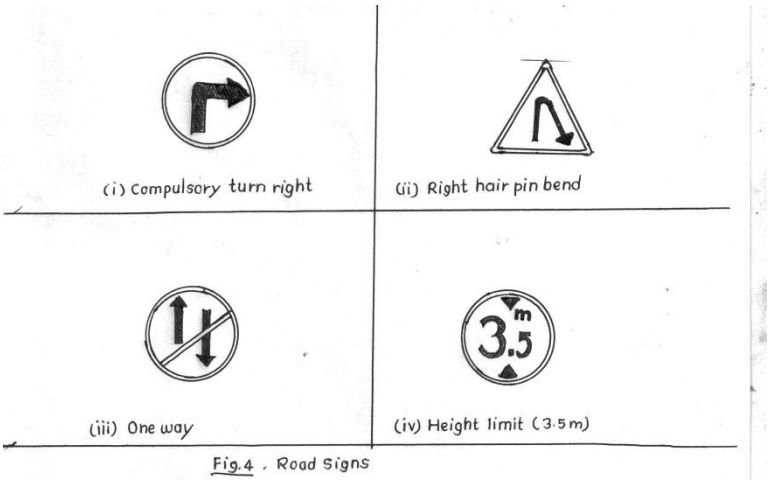
Ans :</td><td>Attempt any ONE of the following:
Differentiate between rigid pavements and flexible pavements with neat sketch

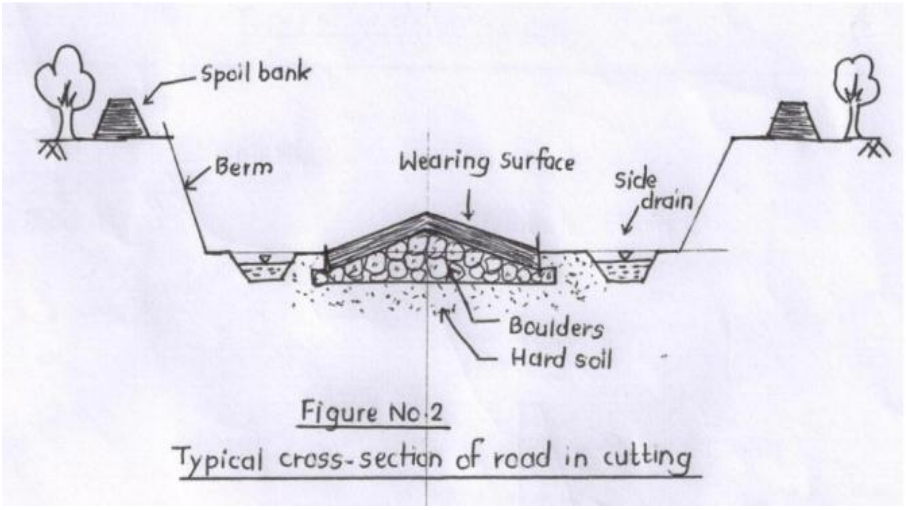
<table>
<tr><th>Sr. No.</th><th>Flexible pavement</th><th>Rigid pavement</th></tr>
<tr><td>1</td><td>It undergoes the change its shape before is failure</td><td>It does not undergo such change, but fails due to rupture under load</td></tr>
<tr><td>2</td><td>Temperature variation does not produce stresses</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>
</table></td><td>1 mark each (Any Four)</td><td>6

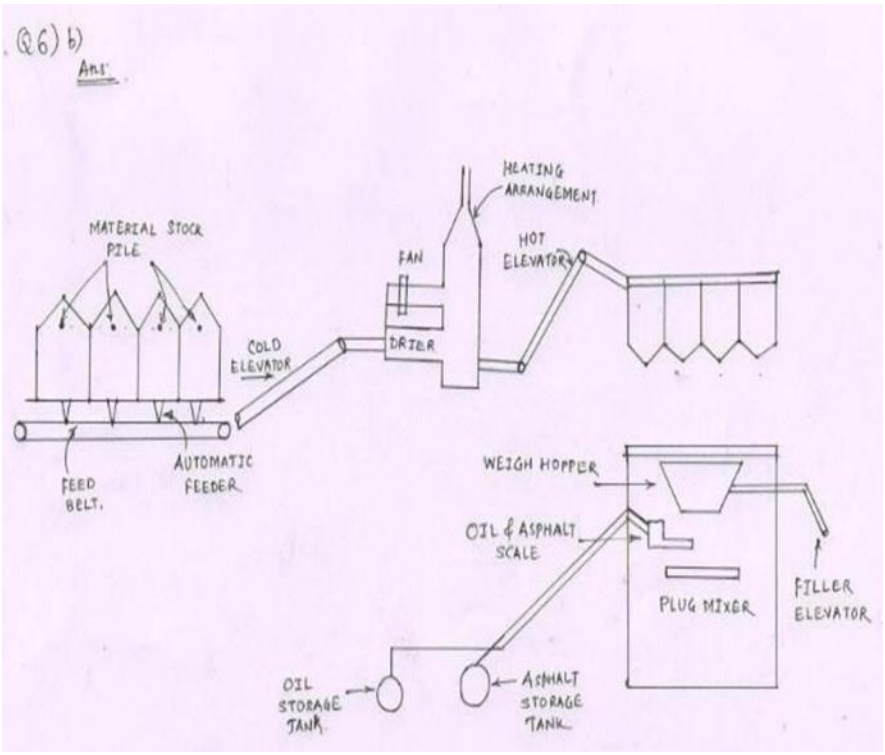
6</td></tr>
</table>

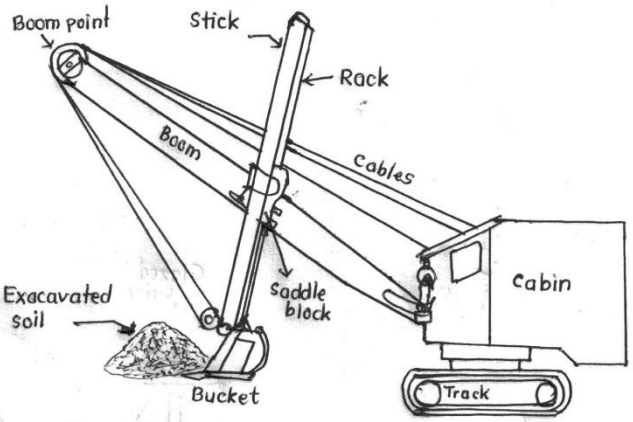
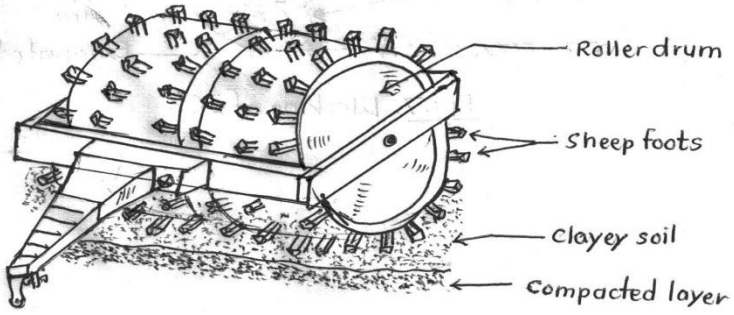
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4	**i)**	**10** Less durable / More durable **11**  	**2 marks for sketch**	**6**
	ii) Ans :	**Describe with neat sketch CBR Test on soil as a subgrade material** CBR Test on subgrade soil - 1. Take the soil sample of size 4.75mm to 20mm and add water required for it MDD i.e. Optimum Moisture Content of that soil. 2. Fill this wet soil in inverted CBR mould by compacting each layer with 56 blows of 2.6 Kg hammer. 3. Place CBR mould in regular fashion under CBR Test apparatus with spacer disc at top. And apply seating load with 50mm ϕ plunger. 4. Now apply a constant load at a rate of 1.25 mm/min and observe test loads for each 0.5 mm penetration up to maximum 12.5 mm. 5. Finally, draw a graph of load Vs penetration as shown in Fig.3 to note test load at 2.5 mm penetration. 6. Calculate % CBR value as (Test load/Standard load) x 100 7. Depending upon calculated % CBR value, Stiffness of given subgrade soil can be judged as follows.	**4**	

CBR values %	Stiffness (MN/m^2)
2	2080
3	2770
4	3460
5	4160
7	4840
10	5540
20	6920
50	13850
100	22160

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4	**ii)**	8. It indicate that more % CBR shows more stiffness of subgrade soil.  Fig.3. Experimental set up for CBR Test on Subgrade soil	**2 marks for sketch**	
5		**Attempt any FOUR of the following:**		**16**
	a)	**Draw the signs for the following- i) Compulsory turn right ii) right hair pin bend iii) one way iv) height limit (3.5)**		
	Ans :	 Fig.4 . Road Signs	**1 mark each**	**4**

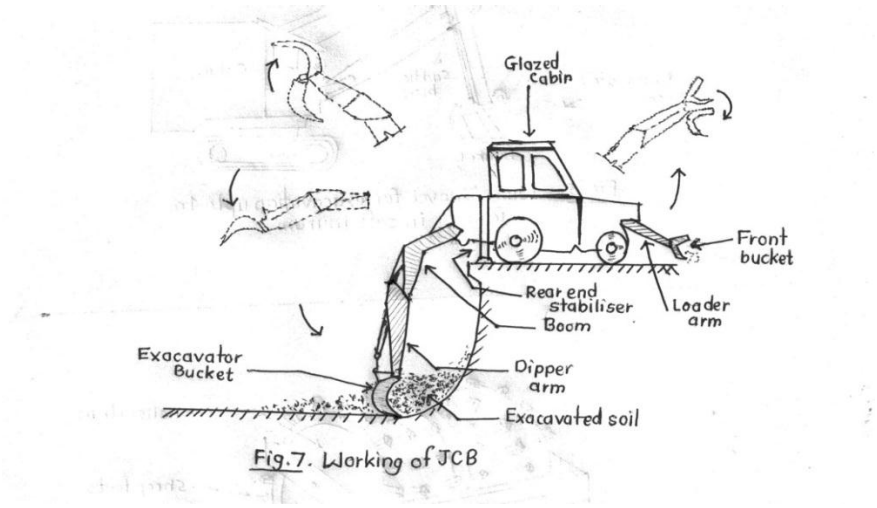
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5	b) Ans :	**Describe prevention techniques of landslides** **Preventive measures for land slide :** 1) Providing effective drainage system using catch water drains. 2) Providing appropriate slopes to minimize erosion of soil. 3) Providing jute netting and wire netting for stability of slopes 4) Application of asphalt mulch treatment to slopes for stability 5) Removal of vegetation to avoid growth of cracks 6) Using chemical treatment for ground surface 7) Relocation of highway in unavoidable landslide regions	**1 mark each (Any Four)**	**4**
	c) Ans :	**Draw the cross section of highway in cutting and label its components.**  Figure No.2 Typical cross-section of road in cutting **(Note-2 marks for sketch and 2 marks labeling)**	**4**	**4**
	d) Ans :	**State types of maintenance of roads and explain one in detail.** **Types of maintenance -** i) Routine repairs ii) Periodical repairs iii) Special repairs iv) Special repairs to monsoon damage v) Resurfacing vi) Renewals vi) Repairs to bridges and culverts.	**½ marks each (any four)**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5	d)	**Routine repairs-** It includes repairing of road patch work, earth work .The repairing of shoulder, drainage system of road comes under routine repairs. The routine repairing also includes repairing of road furniture, road signs and arboriculture. The routine repair is made frequently (say twice in a month) and requires in heavy traffic roads. **(Note -Any other relevant method should be considered)**	**2**	**4**
	e) **Ans :**	**Draw Layout of Hot mix bitumen plant.**  **(Note-2 marks for sketch and 2 marks labeling)**	**4**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5	f)	**Name and draw sketch of suitable equipment for the following road construction activity** **i) Excavation up to 1 m depth in soft murum** **ii) Compaction in soft clay soil**		
	Ans :	 Fig.5. Power Shovel for exacavation upto 1m to in soft murum	**2**	**4**
		 Fig.6. Sheep foot roller for compaction in soft clay soil	**2**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6		**Attempt any FOUR of the following:**		**16**
	a) Ans :	**State four compacting equipment's and its suitability.** **Compacting equipment and its suitability** **i) Smooth wheeled rollers -**for compaction of earth roads, WBM roads, bituminous concentrated layers **ii) Sheep foot rollers** -for consolidation of earth embankments (cohesive soil), earth filling **iii) Pneumatic tyred rollers-** for compaction of cold laid bitumen, soft soil bases **iv) Vibratory rollers-** for compaction of granular base course, asphaltic concrete work. **v) Rammers or Hand operated compactors-** for compaction of trenches, slopes, behind bridge abutments	**1 mark each (Any Four)**	**4**
	b) Ans :	**State use of following equipment's-** **1. Bulldozer 2. Scraper 3. Grader 4. JCB** **Bulldozer -** 1. For clearance of shrubs and small trees. 2. Backfilling of trenches and spreading of earth fill. **Scraper-** 1. To scrap the ground at specific level 2.To remove excessive undulations in earthwork **Grader-** 1. To construct earth road quickly. 2. To give proper shape to the road subgrade. **JCB –** 1. To excavate the earthwork for construction of foundations. 2. To collect and dispose of excavated material.	**1 mark each**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6	**c) Ans :**	**Describe the alignment survey for hill roads.** **The alignment of hill road is fixed and translated on ground through following operations-** a) **Reconnaissance –** It is done through aerial and ground mediums to know physical ground features of proposed alignments of hill road. Aerial photographs taken are verified physically through site visit . The various probable alignments and its data is collected separately b) **Preliminary Survey-** In this each alignments are studied very carefully to get information of traffic , construction materials, slope , drainage conditions. This information is taken such that design features like length , width , slope etc. for all alignments will be helpful. Trace cut 1 to 1.2 m wide are made by pegging the boundaries , the permanent features are marked using offsets and maps are prepared of larger suitable scales c) **Determination of final center line –** in this l/s and c/s contour maps of alignment are studied for satisfying aesthetic, engineering, economic and environmental requirements. Earthwork , curves , obstructions , protective works are considered simultaneously . the grade line is marked on ground using abney level and control points are marked for horizontal and vertical curves for alignment d) **Final location of alignment-** The marked center line on prepared map is then studied in office for estimate and theodolite survey. It is then marked by pegs at 20 m intervals along center line and cross sections. Sometimes the said marking are made with paints . the stakes are marked using theodolite at 10 m at curved alignment of hill road	**1 mark each**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6	**d) Ans :**	**Explain maintenance of bituminous roads** Maintenance of bituminous road→ The bituminous road surface should be maintained through following repair works **i) Pot hole repair or patch repair**- potholes or patches can be repaired by using sand premix, 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 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.	**1 mark each (Any Four)**	**4**
	e) Ans :	**Explain working of JCB with suitable line sketch**  Fig.7. Working of JCB	**2**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6	**e)**	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 fig. 7 below. ii) Then the deeper arm having excavator bucket attached to its end; is stretched up to target ground surface. 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 it's 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.	**2**	