Winter – 2015 EXAMINATION

MODEL ANSWER

Subject: Highway Engineering Subject Code: 17602

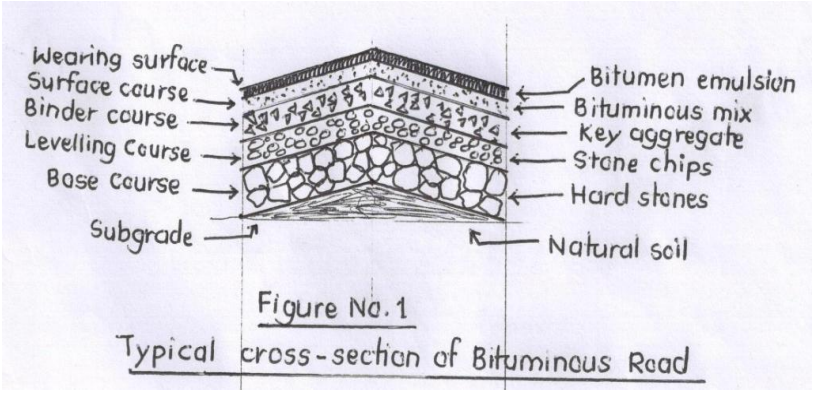
Important Instructions to examiners:

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 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.

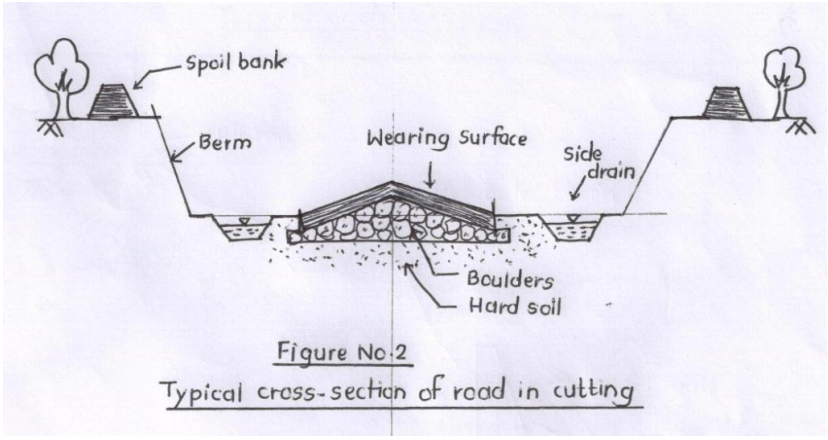
Model Answer

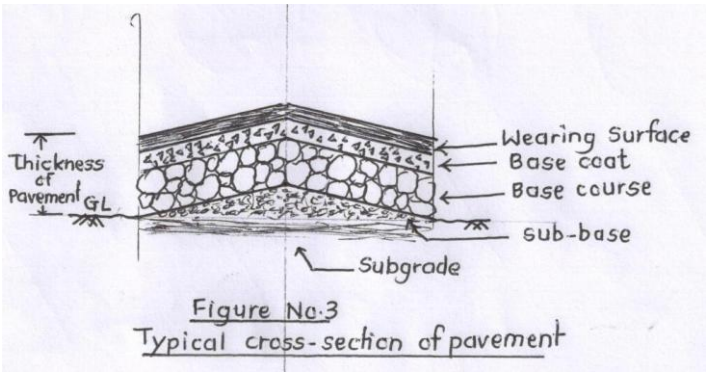
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1)	a)	**Attempt any <u>THREE</u> of the following:**		12
	Qi)	State the importance of road transportation in overall development of a country.	Any 4 points, 1 Mark each	
	Ans.	Importance of road transportation in overall development of a country. Road transportation is beneficial in various fields mentioned below. It may contribute directly or indirectly in overall development of country.		
	i)	Road transportation is helpful in transportation of people's goods etc from one place to other, which results in better & effective communication.		4
	ii)	It is also useful in carriage of agricultural products and dairy products to market.		
	iii)	Roads are necessary for navigation in military or defense area of our country.		
	iv)	Road transportation is easy, simple than railway, which reaches at rural areas and hilly areas also.		
	v)	Roads are economical in construction due to local materials, adjustable gradient.		
	vi)	Road construction gives employment to people and revenue through road taxes.		
	vii)	Country gets more income through tourism with the help of road transportation facility.		
	viii)	Road transportation helps in flood and famine relief.		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1)	a) Qii) Ans.	State the classification of road according to third road development plan. Classification of road according to third road development plan. The roads across the country are categorized into three groups as mentioned below. The third road development plan is based on grouping of roads according to priority for importance in development.	1 mark	
	i)	Primary System: In this group two types of roads are included, namely: a) Expressway b) National Highway. These roads are of prior importance in development of nation. The maximum expenses would be made for construction of these roads	1 mark	4
	ii)	Secondary System: In this second category, moderate important roads like a) State Highway and b) Major district roads are clubbed together. These roads are necessary for routine communication and are of medium importance. This development plan is put up on optimum budget for this group of roads.	1 mark	
	iii)	Tertiary system: In this road system, low cost roads i.e. a) Other district roads and b) Village roads are considered. These roads are provided with least possible expenditure ion twenty year plan. These roads are low budgeted, hence grouped in tertiary system.	1 mark	
	Qiii) Ans.	Define alignment of road. State any four factors controlling road alignment. Alignment of road: Alignment of road is defined as the centerline marked of a proposed route in plan. Factors affecting alignment of road: 1) Nature of ground (hilly or flat) 2) High population zone. 3) Obligatory points (existing structures) 4) Nature of sub – soil strata. 5) Cost of land acquisition. 6) Number of cross- drainage work.	2 marks Any 4 points, ½ mark each	4
	Qiv) Ans.	What are main objectives of preliminary survey? Main objectives of preliminary survey: The preliminary survey for any road construction project is done for following objectives	Any 4 points, 1 mark each	
	i)	To collect data and information of soil strata, annual rainfall from local or native peoples.		4
	ii)	To gather information regarding trees, slope of ground, hill or valleys etc.		
	iii)	To find the approximate feasible alignment and curves by conducting simple field tests.		
	iv)	To study available toposheets and drawings of proposed area.		
	v)	To determine approximate estimate considering all related factors including land costs.		
	vi)	To know number of cross-drainage works and other obligatory points		

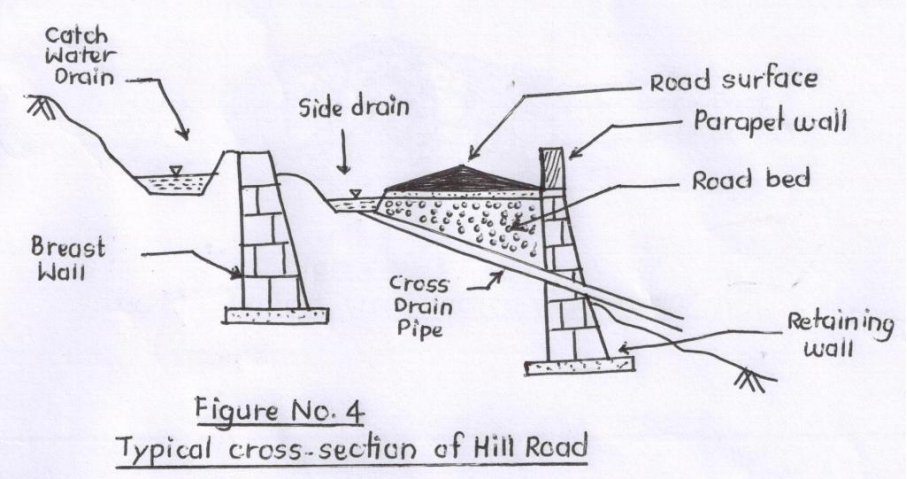
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
	Qv) Ans.	What is camber? State IRC values of camber for different roads. Camber – It is the transverse slope provide to the carriage way OR - It is the surface joining crown point to the road edge point. IRC values of camber for different roads: 1) Earth road : 3 to 4 % 2) Water Bound Macadam road : 2.5 to 3 % 3) Bituminous road : 2 to 3 % 4) Cement concrete road : upto 2 %	2 marks 2 marks, ½ mark each,	4
1)	b) i) Ans. i)	**Attempt any ONE of the following:** Explain construction procedure of bituminous road. Construction procedure of bituminous road: The bituminous road can be constructed by using following basic stepwise procedure: 1) Preparation of subgrade: The existing ground is made clean to remove dust and other unwanted particles using brooms. A thin layer of liquid bitumen is spread evenly on thin clean surface. 2) Preparation of base course: The hard stone aggregate of specified size is spread approximately along the width of road. These are then compacted using vibratory roller of 6- 10 tonne capacity. Now a thin layer of liquid bitumen as prime coat is spread manually or mechanically. 3) Application includes stone chippings and key aggregate, which are bound together using tack coat followed by roller compacting as per design camber on both sides. 4) Preparation of wearing surface: The wearing surface is laid over one layer surface3 course of bituminous mix as shown in fig No. 1. The final layer is applied over seal coat followed by necessary compaction as per gradient of road. 5) The max. undulation of 12 mm of 30 Nos. are allowed in 30m length of road.  Figure No. 1 Typical cross-section of Bituminous Road	04 marks 02 marks	6 6

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1)	b) ii) Ans:	Calculate the passing sight distance for a two way highway with one way traffic and having design speed 80 kmph. The rate of acceleration of fast moving vehicle is 4 kmph/sec and difference in speed between overtaking vehicle and slow moving vehicle is 20 kmph. Given: Two way highway with one way traffic Design speed v = 80 kmph Rate of acceleration a = 4 kmph/sec. Difference in speed m = 20 kmph Find passing sight distance = ? Solution: The passing distance for two way highway with one way traffic = d1 + d2 Therefore to find d1 = 0.56 (v - m) d1 = 0.56(80 – 20) d1 = 33.60 m Now to find d2 = 0.28 (v – m) T +2.S Here, S = 0.20 (v-m) +6 S = 0.20 (80 - 20) +6 S =18m And, T √{(14.4S)/a} T√{(14.4 x 18)/4} T = 8.05 sec. Therefore d2 = 0.28 (v – m)T + 2.S = 0.28 (60 – 20)8.05 + (2 x 18) d2 = 171.24 m Hence, passing sight distance (PSD) = d1 + d2 PSD = 33.60 + 171.24 PSD = 204.84m	1 mark 1 mark 1 mark 1 mark 1 mark 1 mark	6
2.	a) Ans.	**Attempt any <u>FOUR</u> of the following** What is land acquisition plan and longitudinal section? Mention their use. <u>Land acquisition plan</u>: The plan showing existing village maps or settlement maps giving the details of property and their survey number. <u>USE</u>: it is useful to acquire land for proposed road construction work. <u>Longitudinal section</u>: The section is taken along the longitudinal direction i.e. along alignment of proposed route. It shows variation of ground surface along alignment at suitable interval of chainages. <u>USE</u>: It is useful to know nature of ground surface (i.e. hilly or valley) in alignment. It helps to decide suitable gradient for balancing earthwork.	1 mark 1 mark 1 mark 1 mark	16 4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2)	b)	Draw typical cross section of road in cutting:  Figure No 2 Typical cross-section of road in cutting	2 marks Sketch 2 marks label	4
2)	c) Ans.	What is overtaking zones? Why it is provided on highway? How the length of overtaking zone is decided? Overtaking Zones: It is the portion or minimum distance provided to view and overtake slower vehicle against upcoming opposite vehicle. It is provided on two lane two way for viewing upcoming speedy vehicle and pass the slow moving vehicle safely without head on collision. The overtaking sight distance or passing sight distance is calculated by following formula: OSD or PSD = d1+d2+d3 Where, d1 = distance covered by overtaking vehicle during perception and reaction time of driver d2 = distance required for overtaking vehicle to move in adjoining lane and move back in the original lane d3 = distance travelled by opposite upcoming vehicle in adjoining lane The total overtaking zone is decided adequate enough to ensure safety for travelling above distances by moving vehicle on road.	1 mark 1 mark 1 mark 1 mark	4

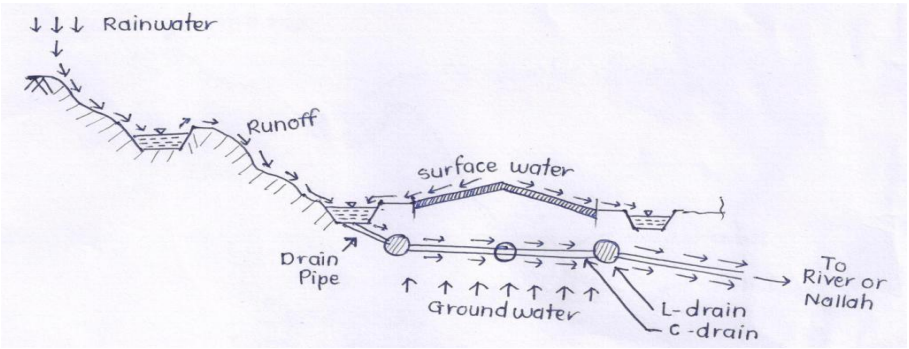
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2)	d.	State the situations under which following gradient are provided: i) Limiting ii) Exceptional iii) Floating iv) Average		
	Ans.	Situations for providing following gradients: i) <u>Limiting gradient</u>: It is provided where topography of the area does not suit ruling gradient due to excessive cost. ii) <u>Exceptional gradient:</u> It is provided under exceptional circumstances and for very short length routes. iii) <u>Floating gradient:</u> It is provided on highly steep sloping ground for constant speed to vehicle without any tractive effort iv) <u>Average gradient:</u> It is provided when ground has moderate variation and ruling or floating gradient becomes unsuitable.	1 mark 1 mark 1 mark 1 mark	4
2)	e Ans	Functions of component parts of pavement: Pavement:  Figure No.3 Typical cross-section of pavement <u>Subgrade:</u> i) To support total layers of pavement ii) To carry load of pavement (DL) + load of traffic (LL) <u>Sub – base:</u> i) To increase load carrying capacity of subgrade. ii) To drain off rainwater & groundwater rise away from sub grade <u>Base course</u>: i) To take superimposed traffic load by acting as foundation of road. ii) To absorb vibrations produced due to continuous moving loads. <u>Base coat:</u> i) To transmit/ transfer load from wearing surface to base course. ii) To bind the wearing surface with compacted base course. <u>Wearing surface</u>: i) To provide passage for actual movement of traffic. ii) To drain off rainwater quickly for avoiding entry in sub layer.	2 marks sketch 2 marks functions of any four parts	4

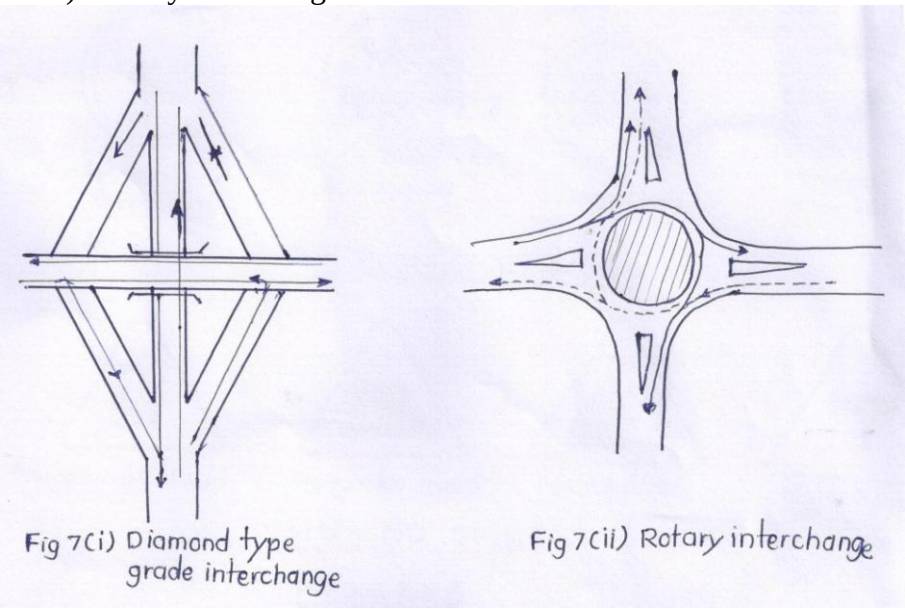
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3	a	Attempt any FOUR of the following: What is equilibrium super elevation? Determine the permissible speed on a curve having radius of 150 m with super elevation of 15% and coefficient of friction 0.6 Equilibrium super elevation: The amount by which outer road edge is raised with inward inclination so that the centrifugal force acting on vehicle will be counter balanced by self weight of vehicle, such elevation is known as equilibrium elevation. Given: R = 150 m e = 15 % = 15 / 100 = 0.15 f = 0.6 Find, V = ? Solution by formula, $e + f = V^2/(127 \times R)$ $0.15 + 0.6 = V^2/(127 \times 150)$ $0.75 = V^2/(19050)$ $V^2 = 14287.5$ $V = 119.53 \sim 120$ kmph Therefore permissible speed V = 120 kmph.	1 mark 1 mark 1 mark 1 mark	16 4
3	b Ans	Estimate the extra widening required for a pavement of width 7m (two lane) on a horizontal curve of radius 250 m. If the longest wheel base of vehicle expected on a road is 8m. Design speed is 60 kmph. IRC recommended value of extra widening is 0.6m. Given: Number of lanes n = 2 Length of wheel base l = 7m Design speed V = 60 kmph Radius of curve R = 250 m IRC value of extra widening W_{min} = 0.6 m Find: Total extra widening = W = ? Solution: By formula, Total Widening = Mechanical Widening + Psychological widening $W = (N l^2) / (2 \times R) + (0.1V) / (R^{1/2})$ $W = (2 \times 7^2) / (2 \times 250) + (0.1 \times 60) / (250^{1/2})$ $W = 0.256 + 0.399$ $W = 0.655$m Total widening required = W = 0.655m	2 marks 1 mark 1 mark	4

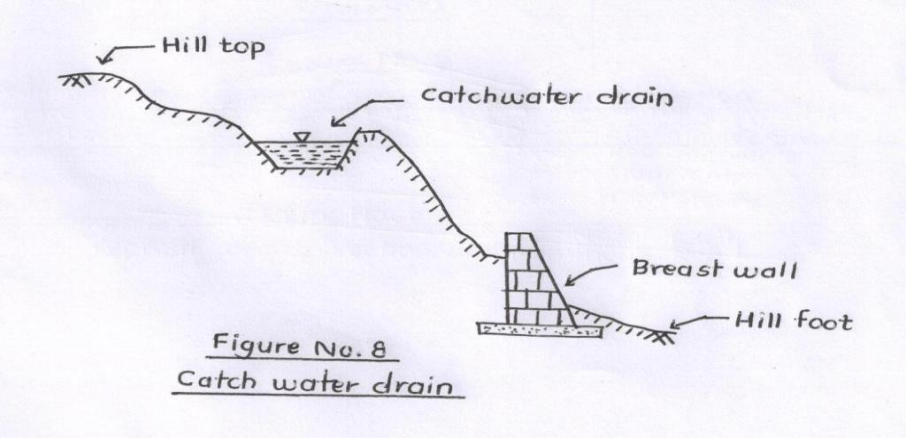
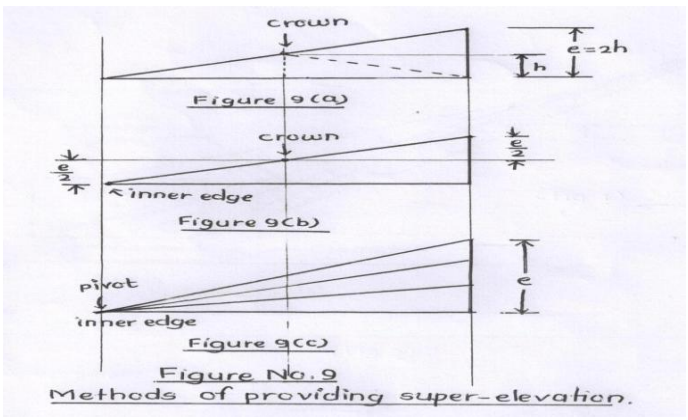
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3	c Ans:	Draw the cross section of a typical hill road and label the component parts. Typical hill road and the component parts.:  Figure No. 4 Typical cross-section of Hill Road	2 marks sketch 2 marks label	4
3	d Ans	Define soil stabilization with necessity: Explain mechanical soil stabilization. <u>Soil Stabilization:</u> The process of improving bearing capacity of an ordinary road soil by physical, chemical or physiochemical method is called as soil stabilization <u>Necessity of soil stabilization:</u> 1) It is useful to increase shear strength of road soil 2) It is necessary to enhance stability of slopes in soil. 3) It helps to reduce material cost by making best use of locally available material. 4) It becomes necessary to reduce rainwater and groundwater entry in pavement surface. Mechanical soil stabilization: In this type, soil stabilization is done without adding chemicals or add-mixtures. It is done in low cost roads and sub grades and sub bases of moderately loaded roads It is done by adding or removing soil constituents based on particle size distribution analysis. The heavy roller compaction is done to densify the soil mass with addition of aggregates if required.	1 mark Any 2 points, ½ mark each 2 marks	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3	e	State the properties of joint sealer. Also state the joint sealer material. Properties of joint sealer: 1) Joint sealer materials should adhere to the edges of concrete. 2) It should not be fractured anytime 3) It should resist the grit entering in the joint. 4) It should be more durable. Materials of joint sealer : 1) Bitumen 2) Rubber Bitumen 3) Air blown Bitumen 4) Cork or cork bound bitumen	4 points, 2 marks 4 points, 2 marks	
4	a	**Attempt any <u>THREE</u> of the following**		12
	i)	Define the following terms: 1) Borrow pits 2) Spoil bank 3) Lead 4) Lift		
	Ans	Definitions: **1) <u>Borrow pits</u>:** The trench excavated along the alignment of road for use of excavated soil for earth road construction, is known as borrow pits. **2) <u>Spoil bank:</u>** it is the storage of surplus soil excavated from borrow pits, is known as spoil bank. **3) <u>Lead:</u>** it is the horizontal distance upto which excavated material is transported for dumping, for which contractor does not get paid extra, is known as lead. 4) **<u>Lift:</u>** It is the vertical distance upto which soil can be excavated, for which contractor does not get paid extra payment, is known as lift.	1 mark 1 mark 1 mark 1mark	4

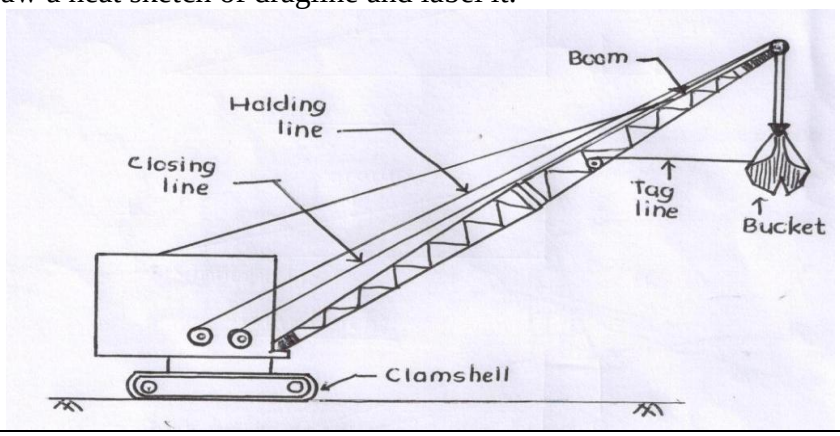
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4	a ii) Ans	State the information rendered by traffic volume study. Information rendered by traffic volume study: 1) The total number of vehicles crossing the particular road intersection in a specific period. 2) The idea of relative importance of a particular road and to classify it. 3) It renders traffic density and traffic capacity, of road which helps to decide widening, laning or over and under passes. 4) It furnishes the daywise or hourly variation in traffic volume to know peak hours. 5) It also results in highly traffic dense route at a road intersection. 6) It gives bifurcation of pedestrians and vehicles at different localities of a city.	Any 4 points, 1 mark each	4
4	a iii) Ans	Draw the sketches of regulatory sign and warning sign (four each). Sketches of regulatory signs and warning signs. 	8 signs, ½ mark each	4

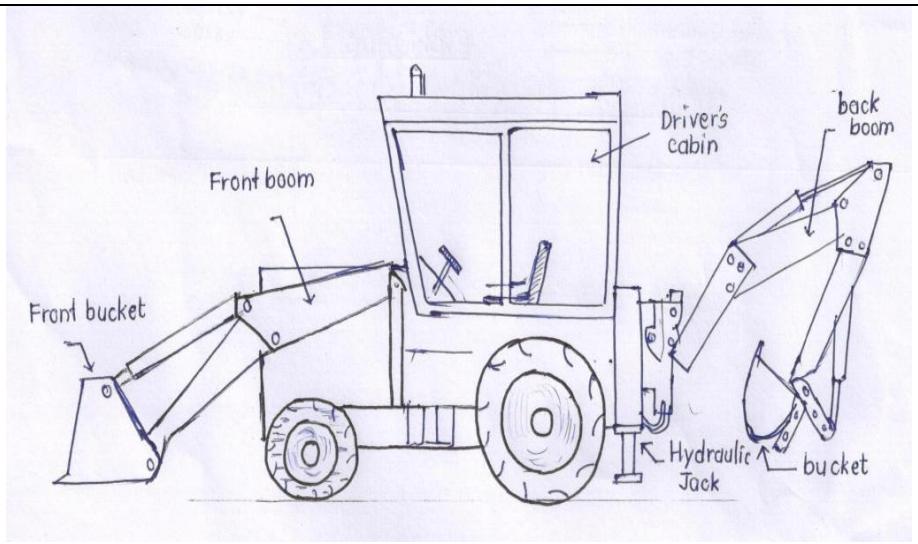
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4	a iv) Ans	Define "Drainage". State the types of drainage system. Draw the sketches showing the different ways through which water enter into structures. Drainage: It is the road system in which surface or subsurface water is collected and disposed off from road structure to any desired location, is known as drainage. Types of drainage system 1) Surface drainage system 2) Subsurface drainage system Different ways through which water enters into structures:  	1 mark 1 mark 2 marks, sketch	4
4	b i) Ans	**Attempt any <u>ONE</u> of the following:** During the construction of WBM road, what precautions are necessary for rolling and finishing? Precautions to be taken for rolling and finishing during construction of WBM road: 1) Rolling of WBM surface should be done by heavy roller of 8 – 10 ton capacity. 2) Rolling should be done from edge to crown 3) Rolling should be done in strips with overlapping 4) The rolling length should be around 200m 5) Rolling should be done for about 80 passes until refusal 6) Rolling should be done at one and same place 7) Rolling should be done by sprinkling water uniformly and should not be poured by buckets. 8) Rolling should give uniform finishing, hence it should be discontinued before crushing of road aggregates.	Any 6 points, 1 mark each	6 6

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4	b ii)	State the sequential operations involved in construction of cement concrete road. Sequential operations involved in construction of cement concrete road: 1) Preparation of subgrade by proper compaction 2) Provision of sub base to support subgrade 3) Placing of forms i.e. Steel channels 4) Batching and mixing of materials in plant 5) Transportation and placing of concrete through RMC vehicle 6) Compaction of poured concrete using vibrators 7) Floating of concrete using steel beam 8) Brooming of concrete surface using steel brush 9) Edging of concrete for obtaining sharp edges 10) Curing of road surface by ponding method 11) Filling of joints using joint sealers 12) Opening of traffic after cleaning	12 points, ½ mark each	6
5	a)	**Attempt any <u>FOUR</u> of the following** Draw the sketches of : i) Diamond types grade interchange ii) Rotary interchange  	2 marks each for labeled sketches	16 4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5	b Ans	Explain with neat sketch 'catch water drains' Catch water drain: These drains are provided to collect excessive rainwater in heavy rainfall regions i.e. in case of hill roads These drains are useful to avoid large water flow reaching to hill road surface. It helps to avoid landslides in hill roads. It may be excavated natural rock section on hill top side which avoids erosion of soil along hill road. The typical catch water drain of trapezoidal section is shown below in figure:  Figure No. 8 Catch water drain	2 marks description 2 marks sketch	4
5	c Ans	Explain with sketch methods of providing super elevation. Methods of providing super elevation The super elevation can be provided by following methods 1) It can be provided to cross – section of road such that outer half part is raised twice of crown height as shown in figure below. 2) It can be also provided on horizontal road by lowering inner edge by half of super elevation with simultaneously increasing outer edge with same half of super elevation by taking crown as pivot point as shown in figure below: 3) Super elevation can be also provided with respect to inner edge of road as pivot point (refer figure)  Figure No. 9 Methods of providing super-elevation.	Any two points, 1 mark each 2 marks	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5	d Ans	Prepare the schedule of maintenance operations required in the period from June to April. The road maintenance from June to April should be done through following operations. June to September: i) Attending patch repairs if any ii) Attending cuts developed by drains iii) Draining water by cutting berms iv) Attending drains and other damages caused by rains v) Stabilization of berms by pitching October to December: i) Repairing of patch works ii) Renewal of coats iii) Repairing of damages caused by rains iv) Repairing of scours in culverts and cleaning of silts if any v) Attending road signs, kilometer stones, boards etc. January to March: i) Repairing of patchwork ii) Repairing and inspection of bungalows and gang huts etc. iii) Renewal and improvement works.	1 ½ marks 1 ½ Marks 1 mark	4
5	e Ans	State the uses of following equipment during construction of highway. Uses of following equipment during construction of highway i) Power Shovels: For digging and loading earth or fragmented rock and for mineral extraction ii) Drag Lines: For excavation of side drains in road in cutting iii) Rippers: For ripping i.e. breaking ground surface rock or pavement into small rubble iv) Scrappers: For scrapping earth and move over portion of road surface	1 mark each	4
5	f	Explain the working of hot bitumen plant. Working of hot bitumen plant : The working of hotmix bitumen plant is completed through following sequential operations i) Aggregate storage and cold feeding: The cold aggregate are stored in cold bins, which feeds proportionally through cold feed gates. ii) Aggregates drying and heating: The fed aggregates are carried using belt conveyor or bucket elevator to dryer, followed by heating and removal of dust. iii) Screening and storage of hot aggregates: In this, dried and heated aggregates gets screened for separation of aggregate fractions and stored in hot bins temporarily. iv) Storage and heating of bitumen: The bitumen is supplied for heating and stored in binder storage tank. v) Measuring and mixing of hot materials: The heated aggregates and bitumen is then added with mineral filler and mixed properly in mixing chamber to produce hot mix bituminous mix which further deposited in dumper using conveyor or trucks for transportation.	Any 4 points, 1 mark each	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6		**Attempt any <u>FOUR</u> of the following:**		16
	a Ans	Types of compacting equipment 1) Smooth wheel rollers 2) Sheep foot rollers 3) Pneumatic tyred rollers 4) Self propelled tamping or pad rollers 5) Self propelled compactors 6) Hand operated compactors 7) Plate compactors 8) Spike rollers	Any 4 point, 1 mark each	4
6	b Ans	Draw a neat sketch of dragline and label it. 	2 marks sketch, 2 marks label	4
6	c	What do you mean by landslides? State four preventive measures for landslides. Landslides: It is the undesirable downward movement of ground due to finite shear failure, is known as 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	2 marks Any 4 points, ½ mark each	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6	d	State the necessity of providing road drainage. 1) Road drainage is necessary to collect surface water in side drains and to keep road surface in dry condition. 2) It is also required to carry sub surface water away from sub layers in heavy rainfall regions 3) It helps to reduce occurrence of road defects due to rainwater and rise of groundwater 4) It is beneficial to minimize landslides and related undesirable effects. 5) It increases load carrying capacity due to dry condition and maintained density of sub layers 6) It also results a good durable road with lesser maintenance as well.	Any 4 points, 1 mark each	4
6	e	 Line Sketch of J.C.B.	2 marks sketch 2 marks label	4