Model Answer: Winter - 2018

Subject: Transportation Engineering | **Sub. Code: 17418**

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.

Q. 1 a) Attempt any SIX of the following: — **Total Marks: 12**

(i) State role of transportation in development of nation. — **Marks: 1 each (any two)** — **Total Marks: 2**

Ans.

Transportation plays a very important role in development of nation in the following ways.

1. Easy and quick transportation of men, machines, animals, material, and goals can be made.
2. Transportation system increases the social awareness among people.
3. Transportation is essential for strategic movement in emergency for defense of the country and to maintain better law and order.
4. Transportation Network creates job opportunities for millions of people.
5. Transportation through air ways plays an important role of communication to the people staying in remote area and also helps the people in difficulties during floods.
6. Areas which are connected by proper means of transport can developed fast.

(ii) Differentiate roadways and railways. — **Marks: 1 each (any two)** — **Total Marks: 2**

Ans.

Sr. No	Roadways	Railways
1	Door to Door Delivery is possible.	Door to Door Delivery is not possible.
2	Suitable for shorter Distance.	Suitable for longer Distance.
3	Starting and Destination points are not fixed.	Starting and Destination points are fixed.
4	Traffic by bus, scooters, cycles etc.	Traffic by train only.
5	Suitable for hilly areas.	Not Suitable for hilly areas.

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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	(iii) Ans.	**State necessity of cross drainage works for railways.** 1. The cross drainage work helps to maintain the continuity of a road or a railway track while going across the river, streams, nala depressions and valleys. 2. It also maintains the gradient in undulating area in case of railway. 3. It provides the continuous access to the surrounding villages and towns even at the time of flood and heavy rain. 4. It maintains the continuous communications.	**1 each (any two)**	**2**
	(iv) Ans.	**Define Points and crossing.** Points and crossing is the special arrangement provided on rail way track to facilitate trains to be diverted from one track to another.	**2**	**2**
	(v) Ans.	**Write any two requirements of a railway station.** 1. Easy and comfortable approach roads connecting the nearby town or village to the station without causing congestions. 2. Availability of coolies on the station platform. 3. Clocks to show correct time, guide map of the city, separate boards for arrival and departure of trains with platform numbers. 4. Provision for arrangements for controlling the movement of trains by means of signals. 5. Sufficient number of sidings for receiving, sorting, storing and departing of trains. 6. Big waiting halls.	**1 each (any two)**	**2**
	(vi) Ans.	**Define afflux and scour.** **Afflux:** It is the rise in water surface of water – course, caused due to the obstruction by the bridge in the flow of water. **OR** **Afflux:** The maximum increase in water level due to obstruction in the path of flow of water is called as afflux. **Scouring:** The process of cutting or deepening of river bed due to action of water is called scouring. When the velocity of stream water exceeds the limiting velocity, it causes vertical cutting of river bed, which is known as scouring.	**1** **1**	**2**
	(vii) Ans.	**Write any two functions of wing wall.** The functions of wing walls are as follows: 1. To retain the earth banks of the river. 2. To protect the earth banks from the action of water.	**1 each**	**2**
	(viii) Ans.	**Define tunnel.** **Tunnel:** The underground passages which are constructed without disturbing the ground surface are known as tunnel.	**2**	**2**

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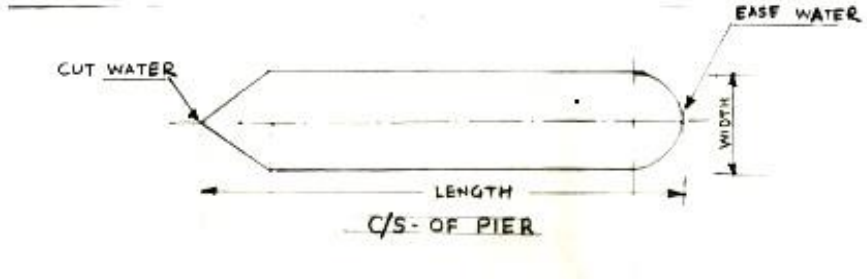
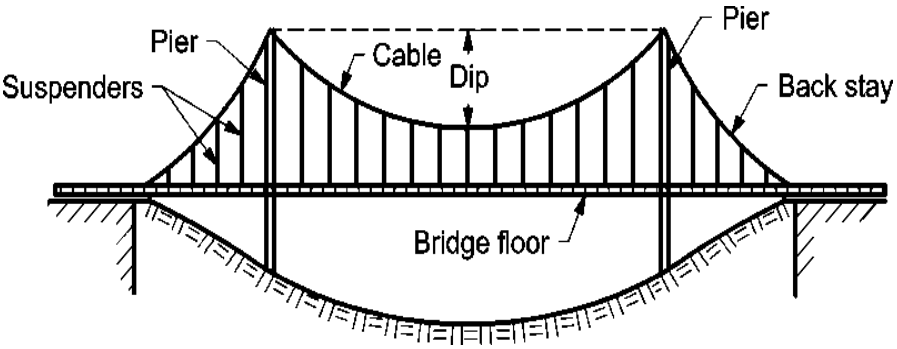
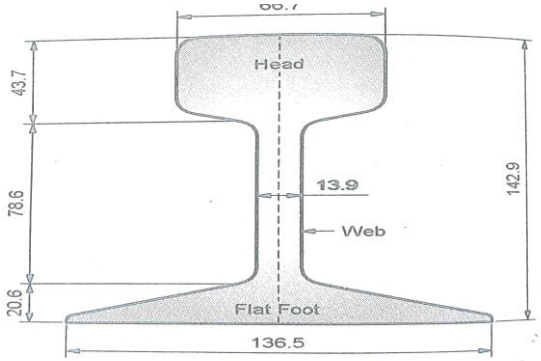
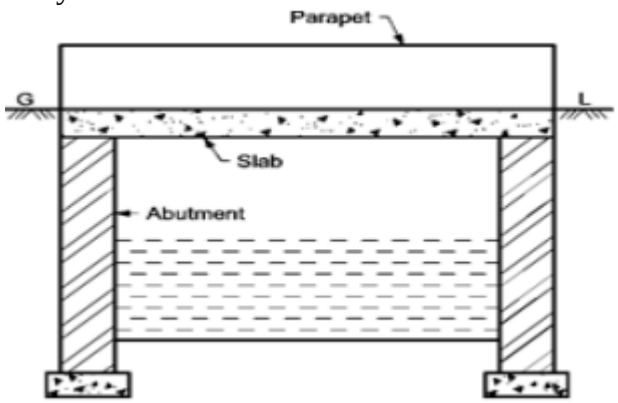
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	b)	**Attempt any TWO of the following :**		8
	(i)	**Define railguage. Describe any three factors that affect the selection of railguage.**		
	Ans.	**Railgauge:** The clear horizontal distance between the inner faces of the two rails forming a track is known as rail gauge.	1	
		The following factors govern the choice for the selection of rail gauge.		
		1. Cost of construction: i. The cost of earthwork, ballast, sleepers, rails, etc. would increase with increase in gauge width. ii. There is little increase in the acquisition of land for permanent track with increase in gauge.	1 each (any three)	4
		2. Volume and nature of traffic: It is evident with greater traffic volume and greater load carrying capacity; the trains should be run by a better traction technique.		
		3. Development of the area: Narrow gauge can be used to develop the thinly populated areas by joining them with developed or urban areas.		
		4. Physical features of the country: Use of narrow gauge is warranted in hilly regions where broad and meter gauge are not possible due to steep gradients and sharps.		
		5. Speed of the movement: The speed of train is almost proportional to the gauge. Speed is the function of diameter of wheel, which in turn is limited by the gauge. The wheel diameter is generally 0.75 times that of gauge. Lower speed discourages the customers and so for maintaining high speeds, broad gauges are preferred.		
	(ii)	**Explain Cut water and Ease water with a labelled sketch.**		
	Ans.	**Cut water and Ease water:**		
		The projection of the pier on the u/s side known as cut water and the projection of the pier on the d/s side known as ease water.	2	4
		 C/S - OF PIER	2	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	(iii) Ans.	**Draw a labeled sketch of a suspension bridge.**  **Fig. Suspension Bridge**	4	4

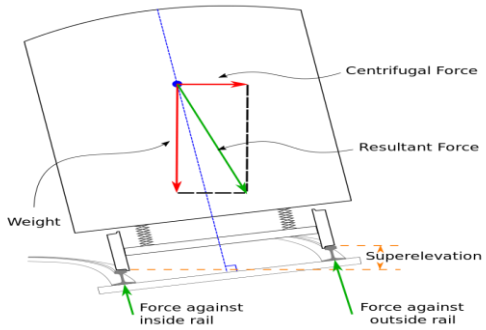
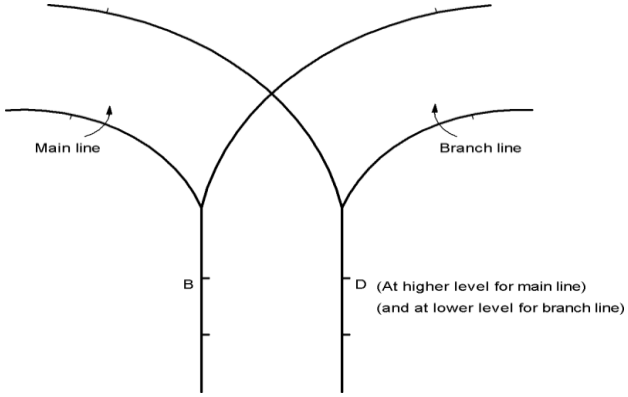
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2		**Attempt any FOUR of the following :**		**16**
	a)	**Write any two functions of rails .Draw a neat labeled sketch of flat footed rail showing all dimensions.**		
	Ans.	**Functions of Rails:** 1. It transmits the moving loads to sub grade through sleepers. 2. It provides hard, strong, smooth and continuous level surface for the movement of train. 3. It serves as lateral guide to the running wheels.	**1 each (any two)**	
		 (c) Flat footed rail (Dimensions are in mm)	**2**	**4**
	(b)	**Write any four requirements of a locomotive yard.**		
	Ans.	**Requirements of a locomotive yard:** 1. It should be properly arranged so that it should carry maintenance in proper sequence. 2. It must be located near passenger or goods yard 3. For lifting engines there should be facility of hydraulic jack. 4. It should be provided with loco shed, water column and fuel platform. 5. It should have overhead tank for supply of water with pressure. 6. It should have sufficient space for future expansion.	**1 each (any four)**	**4**
	(c)	**Write objectives and necessity of track maintenance.**		
	Ans.	**Objectives:** The main object is to provide safe and convenient movement of passenger. **Necessity of track maintenance:** 1. Due to weathering effects, the wear and tear of track component is likely to take place. 2. The new track may disturbed due to heavy axle load frequency in trains.so it has to be checked frequently and periodically for its alignment, gauge and surface level of rails. 3. At points and crossing on curves there might be chances of deteriorion due to high speed and heavy wheel loads. 4. Due to moving loads there may be loss of ballast, wear and tear of different parts of track.	**1** **1 each (any three)**	**4**

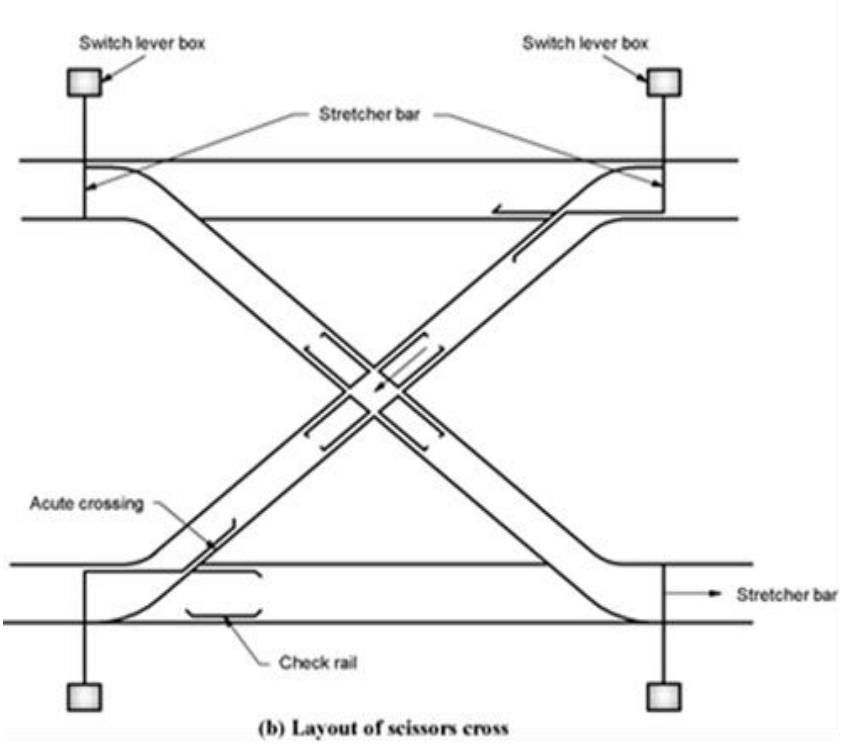
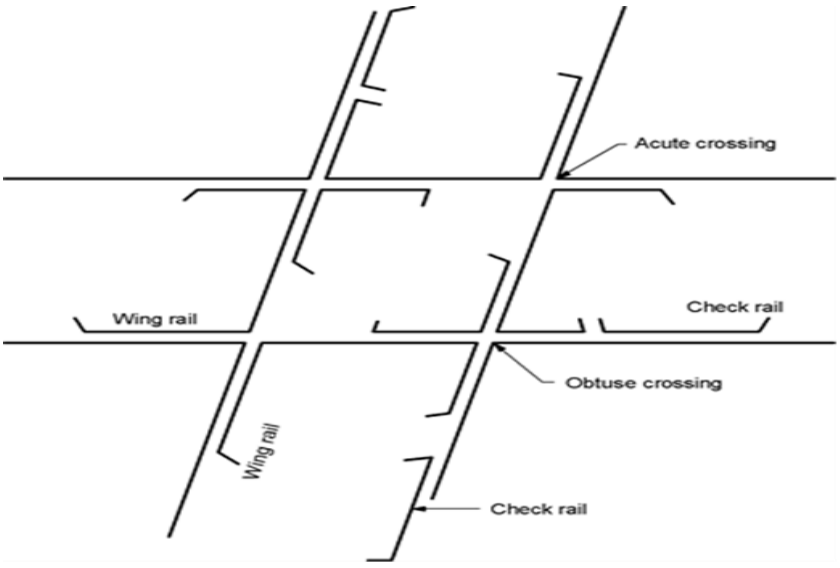
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2	(d) Ans.	**Describe any four factors that affect the selection of site for a bridge.** Following factors affect the selection of site for a bridge: **(1) Width of river :** • The width of river indicates length of bridge. • It is desirable to have well defined and a narrow channel at bridge site as far as possible which will help in providing least possible length of bridge. • The smaller the width of river, the cheaper will be the bridge in its initial cost as well as maintenance cost. **(2) A straight reach :** • The river should have straight reach over a reasonable long distance on upstream side and downstream side of the bridge site so that the utility of bridge can be maintained for the design period. • On the other hand the curved reach of river is not desirable as it creates problems during construction and maintenance of bridge. **(3) Foundations :** • The nature of soil at bridge site should be such that good sound foundations should be available at reasonable depth. • Such type of bridge site will save expense, labour and time required. **(4) Connections with roads :** • The bridge is constructed to connect the road on either side of a river. • The bridge site should therefore form a proper link between the roads on either side of a river. • The approaches at the bridge site should be such that they do not involve heavy expenditure. **(5) Firm embankments :** • The embankment at bridge site should high, permanent, straight, solid and firm. • Such embankments will not get disturbed at the time of heavy floods and they do not allow the course of stream to alter.	**1 each (any four)**	**4**

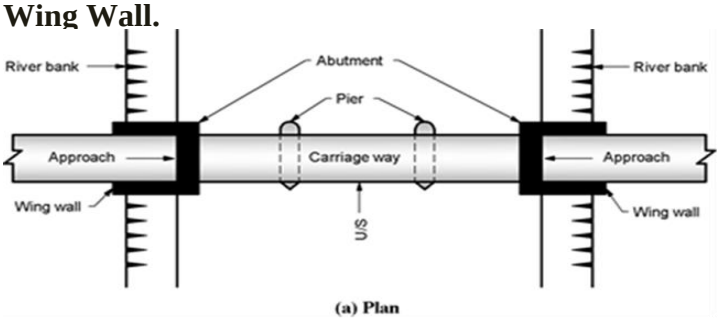
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2	(d) Ans.	**(6) Materials and labour :** • The site of the proposed bridge should be such that labour, construction material should easily available nearby site. • The transportation charges for material and labour at the bridge site should be minimum. • This type of bridge site will provide economy in the overall cost of construction. **(7) Right angle crossing :** • At bridge site, the direction of flow of water should be nearly perpendicular to the centre-line of bridge. Such crossing is known as right angle crossing. • This type of site will help in providing square alignment of bridge which will result in easy and economy in bridge construction. **(8) Velocity of flow :** • The velocity of flow at bridge site should be between the range of non - silting and non-scouring. • This type of site will result in minimum maintenance cost. **(9) Scouring and silting :** • There should be no scouring and silting at bridge site, which will result in minimum maintenance cost. **(10) Minimum obstruction to water way :** • There should be minimum obstruction to natural water way at the site of bridge. **(11) Sound, economical and straight approaches :** • The bridge site should provide sound, economical and straight approaches. • In case of curved alignment, the bridge should be on the tangent and not on the curve, since it is difficult to construct and maintain a curved bridge. **(12) Location of river tributaries :** • The bridge site should be away from the point of influence of large tributaries as far as possible. As it will help to protect the bridge from the possible harmful disturbances. **(13) Free board :** • Sufficient free board should be available for the passage of boats, ships under the bridge superstructure if the river is used for navigation.		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	(e) Ans.	**Write any four functions of bearings.** **Functions of bearings:** 1. To distribute the load received over large area. 2. To allow for longitudinal expansion or contraction due to changes in the temperature. 3. To allow for angular movement at support due to deflection of girders. 4. To allow for vertical movement due to sinking of supports. 5. To transfer horizontal forces occurring due to application of brakes to the vehicle etc. 6. To keep the compressive stress within safe limits.	**1 each (any four)**	**4**
	(f) Ans.	**Give meaning of permanent bridge. Explain slab culvert with a neat sketch.** **Permanent Bridge:** The bridges which can be constructed as well as maintained larger span of useful life are known as permanent bridge.	**1**	
		Slab culvert : 1. A slab culvert consists of stone slabs or R.C.C. slabs supported on masonry wall 2. These culverts are constructed up to the span of 3 m. 3. The construction of slab culvert is relatively very simple. 4. This type of culvert can be used for highway, railway and bridges. Slab culvert are suitable where the bed of stream or canal is sufficiently firm.	**2**	**4**
		 **Fig. Slab Culvert**	**1**	

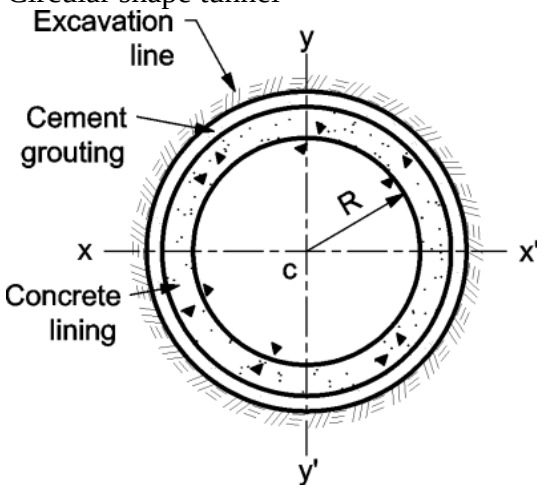
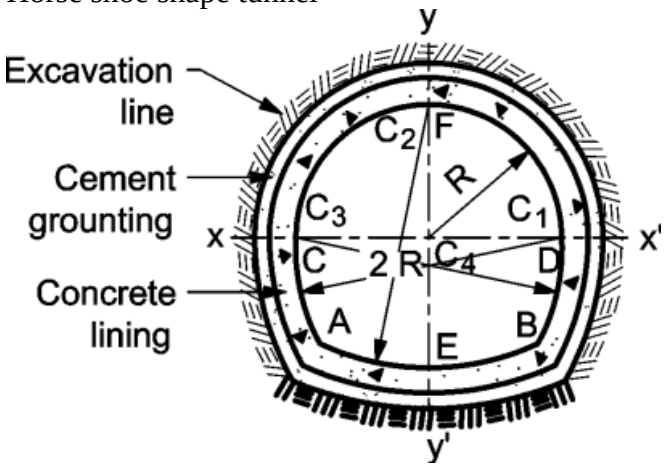
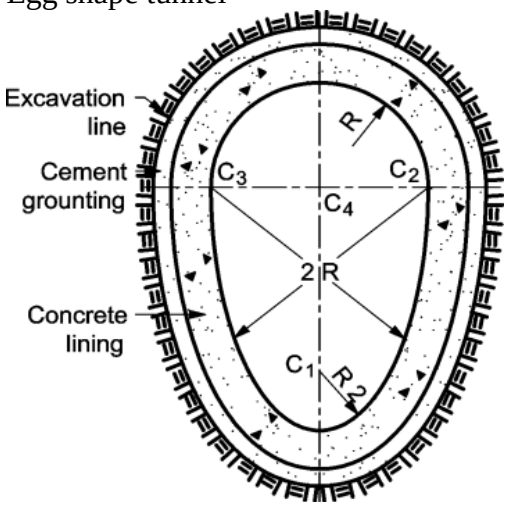
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3		**Attempt any TWO of the following:**		16
	(a) Ans.	**Define creep of rails. Explain causes and prevention of creep.** **Creep of rail:** Creep in rail is defined as the longitudinal movement of the rails in the track in the direction of motion of locomotives. **Causes of creep:** **1. Wave action or Wave Theory:** Wave motion is set-up in a resilient track by the moving wheel loads. The train wheels causes depression under themselves forming lifts or crests. With movement of wheels, the lifts on front of the moving wheels are carried forward whereas the lifts at the rear of the moving wheels get back to their normal position. Thus, the rails are pushed forward which causes creep in the forward direction. **2. Percussion Theory:** The rail creep is due to impact of wheels at the end of facing rail at each fish plate joint as shown in figure. When the wheel pass over such a rail joint the trailing rail depresses down and the wheel give impact to the end of facing rail, which results creep in forward direction. **3. Accelerating or Starting of a train:** At the time of accelerating or starting of a train, the engine wheels give a backward thrust which tends to push the rails backwards, causing creep in the backward direction. **4. De-accelerating or Stopping the train:** When the train is de-accelerated or stopped, the braking effect tends to push the rail forward. Thus, causing the creep in the forward direction. **5. Expansion and contraction of rails due to variation in temperature:** Creep may also be caused due to unequal expansion, contraction of rails due to variation in temperature. **6. Intensities of Traffic:** In a single line track, the creep will be resulted in the direction of heavy intensity of traffic. In a double line track, the creep occurs in both the tracks in the direction of movement of trains. **7. Alignment of the track:** Creep is greater on curved portion than on straight portion of the track. **8. Gradient of the track:** Creep is more on a track with steep gradient, particularly, if the trains move downwards with heavy loads. **Creep Prevention:** 1. Pulling back the rails. 2. Use of steel sleepers. 3. Using Anchors/Anti-creepers. 4. By increasing number of sleepers per rail length.	**1** **1** **each (any four)** **1 each (any three)**	**8**

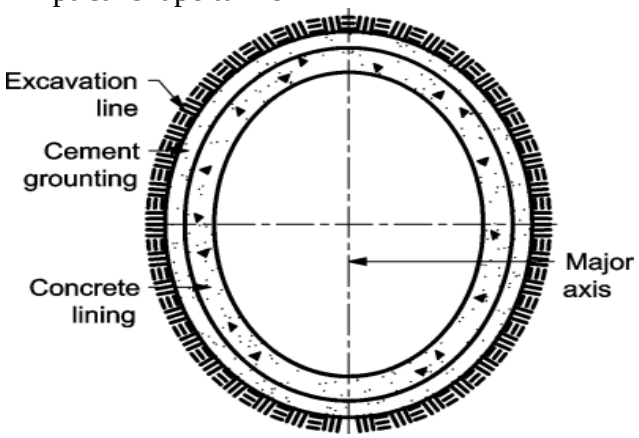
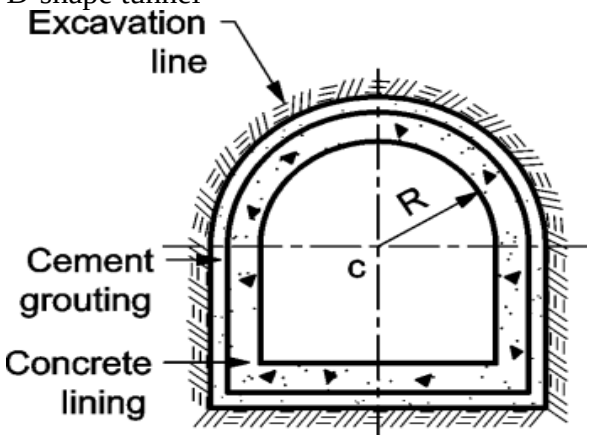
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	(b) Ans.	**Explain Cant Deficiency and Negative Cant with sketch.** **i) Cant Deficiency:** The difference between equilibrium cant necessary for maximum permissible speed on curved track and the actual cant provided is known as cant deficiency. It should be as low as possible, as higher cant deficiency result in extra pressure, more side wear and creep of outer track and results in discomfort to passenger. For different gauges, cant deficiency prescribed by Indian Railway for speed upto 100 km/hrs is 7.6 cm, 5.1 cm, 3.8 for B. G. M. G and N. G respectively and for speed more than 100 km/hr, it will be 10 cm for B. G. only.	2	8
			2	
		ii) Negative cant: a. On the curve where main track and branch track meets then the stage occurs such that the outer rail is below the inner rail, then it is called as negative cant or negative super elevation. b. The negative cant helps the locomotive to change its direction from main line to branch line irrespective that outer rail should kept at higher level. c. Now from fig shows the main track and branch track. The points 'D' is at higher elevation than B as in case of main track. But for branch track or turnout track, elevation of B should be higher than 'D' and thus super elevation provided is negative for branch track and this is called negative cant.	2	
			2	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	(c) Ans.	**Draw the line sketches of scissor Cross over and diamond crossing** **1)Line sketch of scissor Cross over:**  (b) Layout of scissors cross	4	8
		2) Line sketch of Diamond crossing:  	4	

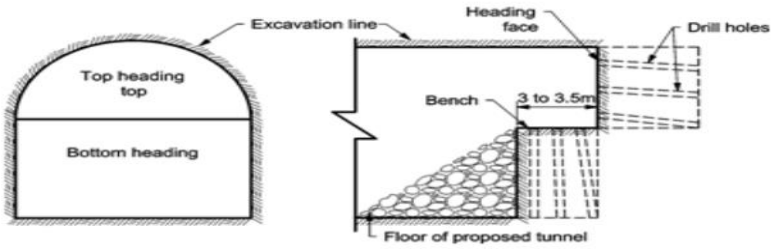
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4		**Attempt any TWO of the following:**		16
	(a)	**Draw a typical plan of Bridge showing all important components. Also define following i) Effective Span ii)Afflux iii) Waterway iv) Wing Wall.**  (a) Plan	4	
		i) Effective Span The center to center distance between any two adjacent supports of the bridge Superstructure is called as effective span.		8
		ii) Afflux It is the rise in water surface of water – course, caused due to the obstruction by the bridge in the flow of water. **OR** The maximum increase in water level due to obstruction in the path of flow of water is called as afflux.	1	
		iii) Waterway The sectional area at the site of a bridge through which water flows is termed as waterway.	each	
		iv) Wing Wall The walls constructed at both ends of the abutments to retain the earth banks of the river or of the bridge approaches are known as wing walls.		
	(b)	**Classify bridge according to function, material, span and alignment.**		
	Ans.	Bridges can be classified into various types depending upon the following factors and condition. **I. According to functions:** a. Aqueduct b. Viaduct c. Foot bridge d. Highway bridge e. Railway bridge	2	
		II. According to materials: a. Timber bridge b. Masonry bridge c. Steel bridge d. Reinforced cement concrete bridge e. Pre stressed concrete bridge	2	8
		III. According to span length: a. Culvert b. Minor bridge	2	

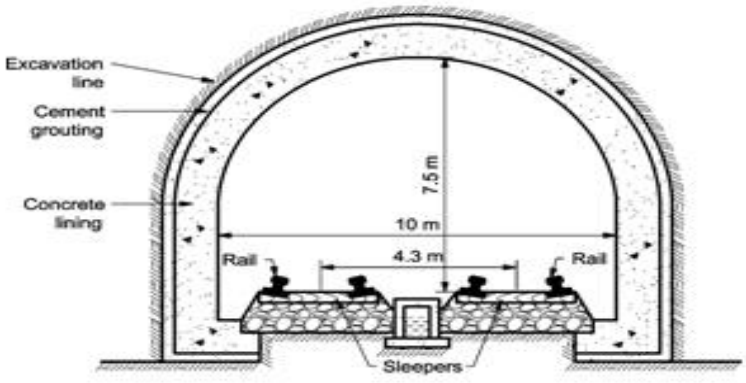
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4		c. Major bridge d. Long span bridge **IV. According to alignment:** a. Straight bridge b. Skew bridge	**2**	
	(c)	**Define Pier. State function, requirements and types of pier.**		
	Ans.	**Piers:** The intermediate supports provided for bridge superstructure are known as piers.	**1**	
		Functions of piers: i) To divide the length of bridge into suitable number of spans. ii) To transfer the load from bridge superstructure to subsoil through foundations.	**1 each**	
		Requirements of piers: 1. It should be easily and cheaply constructed. 2. It should be constructed of durable material. 3. It should have sufficient bearing area at its top to receive the bearings supporting the bridge girder. 4. It should be stable against lateral and longitudinal thrust of water. 5. It should be strong enough to take loads. 6. It should involve less maintenance cost	**½ each**	**8**
		Types of piers: **a. Solid piers: It is classified into two types:** i. Solid masonry piers ii. Solid R.C.C. piers	**1**	
		b. Open piers: It is classified into four types: i. Column bents ii. Pile bents iii. Cylindrical piers iv. Trestle piers	**1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	(a) Ans.	**Attempt any TWO of the following:** **Classify tunnels according to shape and size, position of alignment, materials and purposes with suitable sketches.** **According to Shape and Size of Tunnels:** 1. Rectangular or box type shape 2. Circular shape tunnel  3. Segmental shape tunnel 4. Horse shoe shape tunnel  5. Egg shape tunnel  	2	16

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
		6. Elliptical shape tunnel  7. Polycentric shape tunnel 8. D-shape tunnel  **According to the position of alignment:** 1. Saddle and base tunnel 2. Spiral tunnel 3. Off spur tunnel 4. Slope tunnel **According to the type of materials** 1. Tunnels in hard rock 2. Tunnels in soft rock 3. Tunnels in quick sand 4. Tunnels under river bed **According to the purpose:** **1)Traffic tunnel:** a) Railway tunnel b) Highway tunnel c) Pedestrian tunnel d) Navigation tunnel e) Subway tunnel **2) Conveyance tunnel:** a) Hydro power tunnel b) Water supply tunnel c) Sewage tunnel d) Tunnels for industrial use	**2** **2** **2**	**8**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	b)	**State any four objectives of tunnel ventilation. Explain mechanical methods of tunnel ventilation.**		
	Ans.	**Objectives of tunnel ventilation :** 1. To supply fresh air inside the tunnel. 2. To remove poisonous gases, dust smoke etc. 3. To reduce temperature in tunnel situated at great depth. 4. By providing ventilation in tunnel which helps to reduce suffocation produce during and after construction of it.	4	
		Mechanical ventilation is done by blowing fresh air into a tunnel or by exhausting the foul air or dust from the tunnel by any system listed below : **1. Blowing process :** In this method of mechanical ventilation, fresh air is forced by one or two blowers through the ducts, provided in the tunnel. By this method, positive supply of fresh air at the working place can be obtained. But the disadvantage lies in that the foul air, smoke and dust slowly move out, fogging the atmosphere inside the tunnel, especially in long tunnels. **2. Exhausting process :** In this method of mechanical ventilation, air is sucked by one or two exhaust fans installed near the tunnel heading. This creates vacuum due to which fresh air enters inside the tunnel. This method has the special advantage of quick removal of dust and smoke from the working face. **3. Combination of blowing and exhausting process :** In this method, blower and exhaust fans are provided for forcing fresh air in the tunnel and sucking foul air from the tunnel. The blower and exhaust fans are installed in suitably spaced inlet and outlet shafts connected to the tunnel. Immediately after the blasting operation, the exhausting system is operated for 15 to 30 minutes, to remove the objectionable air. After which blowing system is operated for forcing fresh air in the tunnel. This method provides the most efficient ventilation system of tunnels.	4	8
	(c)	**Describe heading and bench method of tunneling in hard rock with a neat labeled sketch.**		
	Ans.	**Heading and Bench method :** This method is suitable when large section of the proposed tunnel is to be drive and the quality of rock is not very satisfactory. 1. In this method, the driving of the tunnel is done in two portions of its section. 2. The top portion is known as heading and bottom portion is known as bench. 3. The driving of top portion is done in advance of the bottom portion. 4. In this method of tunneling the top portion or heading will be about	6	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
		3 to 3.5 m ahead of the bottom portion. 5. The holes are drilled into head and bench. 6. Then these holes are loaded together with explosive and then blasted. 7. Firing of bench holes is done just before the heading holes are fired. 8. After this mucking is done manually.  (a) Cross section (b) Longitudinal section Fig. Heading and Bench Method	2	8

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6		**Attempt any FOUR of the following:**		16
	(a)	**Write any four general points to be observed while inspecting a bridge.**		
	Ans.	**The following points should be kept in view while inspecting a bridge;**		
		Substructure:		
		1. Condition of mortar joints in case of masonary arch bridge. 2. Condition of bearings, whether functioning properly or not. 3. Any sign of development of cracks in masonary or concrete immediately below the bearings. 4. Condition of abutments, piers and wing walls, whether good weathered or bulged. 5. Any sign of development of cracks in concrete abutments and piers. 6. Any sign of settlement of foundation. 7. Any sign of scour along with maximum depth of scour. 8. Condition of material used in arches in case of arch bridge. 9. Condition of masonary, whether good or weathered.	**1 each (any two)**	
		Superstructure:		4
		1. Condition of wearing coat and its thickness. 2. Condition of kerbs and railings. 3. Condition of expansion joints, whether functioning well or not in case of concrete bridge. 4. Condition of concrete, whether in good condition or not 5. Condition of reinforcement, whether exposed anywhere or not in case of concrete bridge. 6. Condition of paint in case of steel and iron bridge. 7. Condition of steel work, material, members and connections in case of steel or iron bridge. 8. Condition of material used in arches in case of arch bridge. 9. Condition of masonary, whether good or weathered.	**1 each (any two)**	
	(b)	**Draw cross section of tunnel for a double line Broad gauge railway track**.		
	Ans.	 Fig. Cross-section of tunnel for a double line broad gauge railway track.	**4**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	(c) Ans.	**State advantages and disadvantages of tunnel.** **Advantages**: Following are the advantages of providing tunnels. 1. They carry railway lines, roads and public utilities like water, oil, gas etc., across streams or mountains, economically. 2. They eliminate excessive cost of maintenance of an open cut subjected landslides. 3. They connect the two terminal stations by the shortest route. 4. They help in avoiding holding up of traffic for long periods due to traffic congestion and provide rapid transportation in big cities. 5. They help in avoiding acquision of costly land and, property for a railway or road projects. 6. They provide protection to the railway track or road pavements from the effects of rain and other weathering agencies and thus require less maintenance. 7. They provide free movement of traffic throughout the year even during snowfall and landslides. **Disadvantages**: Following are the disadvantages of providing tunnels. 1. They may be costlier in construction as compared to open cut 2. They require more time in their construction as compared to open cut 3. They require special equipment and methods for their construction. 4. They require skilled labour and supervision in their construction 5. They may cause suffocation if not properly ventilated and thus, result inconvenience to the passengers.	½ each (any four) ½ each (any four)	4
	(d) Ans.	**State the precautions to taken during construction of tunnels.** Following are the precautions to be taken while construction of tunnel 1. The shape of the tunnel should be decided according to its purpose. 2. Cross sectional dimensions of the tunnel should be decided to achieve economy in its construction. 3. Economic calculations for extent of equipment and labour should be made before starting the tunnel construction. 4. Pattern of blasting the material in different locations should be decided for maintaining speed of driving and safety. 5. The sequence of operation must be decided so that proper use of labour and equipment is made. 6. Labour should be well organized to maintain continuous progress of the tunneling operations. 7. The use of out dated or unsuitable tools should be avoided. 8. Loading and hauling of muck should be carried out efficiently. 9. In order to achieve economy, the sequence and type of lining should be determined in advance. 10. Pattern of blasting the material in different locations should be decided for maintaining speed of driving and safety.	1 each (any four)	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	(e)	**Define tunnel surveying. State various operations involved in tunnel surveying.**		
	Ans.	**Tunnel surveying:** The process of setting out the alignment of the tunnel on the ground and then transferring the same to inside of the tunnel through shafts is called tunnel surveying.	1	
		i) Locating centre line of the tunnel on ground : • After fixing the route for the tunnel, its centre line (alignment) is accurately set out on the hills or ground. • When the length of tunnel is small, the centre line can be located by means of theodolite. • When the tunnel is long, and to be constructed under high mountains, the centre line is set out by triangulation preferably with the help of a micrometre transit theodolite.	1 each	4
		ii) Constructing the shaft over the centre line : After locating centre line, shafts are constructed at regular interval.		
		iii) Transferring the alignment to inside of the tunnel : • After constructing the shafts, the alignment of the tunnel is to be transferred down the shafts. • Two plumb bobs are suspended inside the shaft by lowering both plumb bobs to the bottom of the shaft, two points are marked. • The line joining the points represents the centre line of the tunnel marked on the ground. • This line is further extended into the tunnel, as work advances, by a theodolite placed in the shafts.		
	(f)	**Define tunnel alignment. Describe various factors that controls tunnel alignment**.		
	Ans.	**Tunnel alignment**: The position occupied by centre line of a tunnel is called tunnel alignment.	1	
		Following are the various factors that controls tunnel alignment: 1. Tunnel should pass through the hard rock, as the chances of accidents are much less as compared to soft rock. 2. The alignment should be such that the excavation work is minimum. 3. The alignment should not be near water channel. 4. The portal of the tunnel should be near the dumping yard so that the muck may be disposed off in lesser time. 5. The alignment should be as straight as possible. 6. Minimum possible grade should be provided in tunnel.	1 each (any three)	4