



Subject: Transportation Engineering

Subject 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.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	a)	Attempt any <u>SIX</u> of the following:	2 M	12
	i) Ans.	Define ' Transportation system'. It is the system, which deals with design, development, construction, and maintenance of roadways, railways, airports, harbors, docks, tunnels, and bridges. Or It is a system in which proper communication facility is planned, designed, and constructed for easy transport of human beings and goods from one place to another.		2 M
	ii) Ans.	State importance of Cross drainage works. Importance of Cross drainage works is as follows- <ol style="list-style-type: none">1. It helps to maintain continuity of a road or a railway track while going across river2. It also maintain gradient in undulating area in case of railway3. Provide continuous access to the surrounding villages and towns even at the time of flood and heavy rain,4. It helps to drain water by scuppers in hilly areas.5. It maintains continuous communication.	1 Mark each (Any Two)	2 M



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	a)	Give the classification of Indian Railways.		
	iii)	Classification of Indian Railways:		
	Ans.	1. Eastern Railway (ER) 2. South Eastern Railway (SER) 3. Northern Railway (NR) 4. North Eastern Railway (NER) 5. Southern Railway (SR) 6. Central Railway (CR) 7. Western Railway (WR) 8. North East Frontier Railway (NEFR) 9. South Central Railway (SCR)	2M	2M
	iv)	Define cant deficiency.		
	Ans.	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.	2M	2M
	v)	Define Afflux:		
	Ans.	Afflux: It is the rise in water surface of water – course, caused due to the obstruction by the bridge in the flow of water. The heading up of the water above its normal level while passing under the bridge is called afflux. Or The maximum increase in water level due to obstruction in the path of flow of water is called as afflux.	2M	2M
	vi)	Define Culvert.		
Ans.	Culvert: A culvert is defined as a small bridge constructed over a stream distributaries or pool etc.	2M	2M	
vii)	Enlist two purpose of tunnel lining.			
Ans.	Purpose of lining : 1. To provide the correct, desired shape to the tunnel. 2. To support the loosened rock pieces during blasting. 3. To increase the structural strength of soft places in the tunnel. 4. To improve the appearance of tunnel. 5. To prevent percolation of water inside the tunnel. 6. To reduce the maintenance cost of tunnel. 7. To house electrical fitting. 8. To withstand soil pressure when driven in soft rocks.	1 Mark each (Any Two)	2M	
viii)	State any two uses of tunnels.			
Ans.	The following are the uses of tunnels; 1. Tunnel connects the two terminal stations of shortest roots. 2. They facilitate less route length and thus results in less transportation cost. 3. They carry railway lines, roads and public utilities like water, oil, gas etc. across a stream or mountain.			



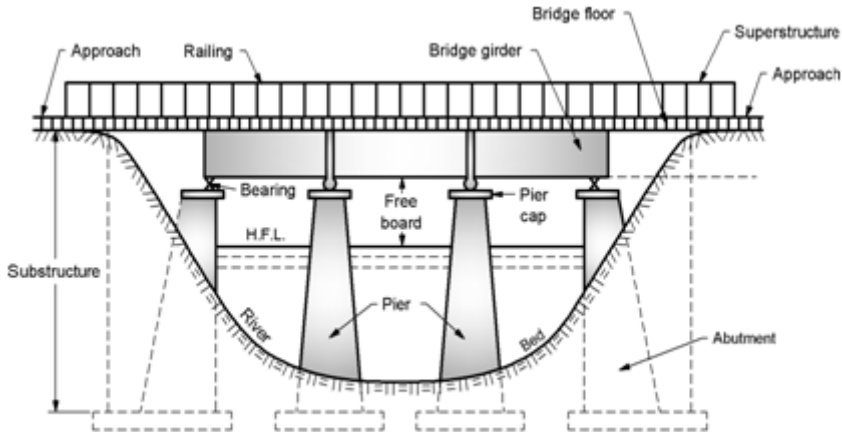
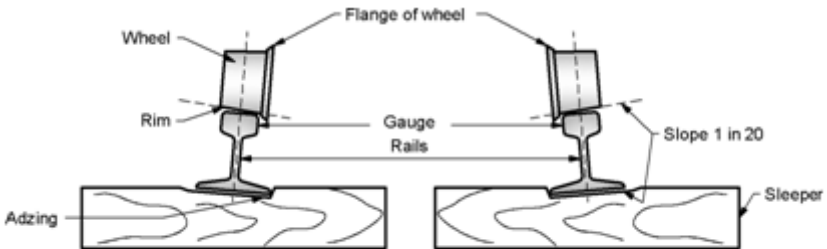
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	a) viii)	<ol style="list-style-type: none">4. Tunnel provides free movement of traffic throughout the year even during snow fall and landslide.5. Tunnel facilities conduction of water to generate the power.6. Tunnel helps in avoiding acquisition of costly land and property for railway or road projects.7. They eliminate excessive cost of maintenance of an open cut subjected to land slide.	1 Mark each (Any Two)	2M
	b) i)	<p>Attempt any <u>TWO</u> of the following :</p> <p>State role of transportation in development of nation.</p>		8M
	Ans.	<p>Transportation plays a very important role in development of nation in the following ways.</p> <ol style="list-style-type: none">1. Easy and quick transportation of men, machines, animals, material, and goods 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.	1 Mark each (Any Four)	4M
	ii)	<p>What is rail alignment? State the factors governing rail alignment.</p>		
	Ans.	<p>Alignment: It is the center line of a proposed track in a plan or marking the position of center line on the ground</p> <p>Factors governing the rail alignment are as follows:</p> <ol style="list-style-type: none">1. Obligatory Points: Alignment of track has to be deviated from straight line because it has to pass through obligatory points like market places, educational centres, etc. Certain undesirable locations have to be avoided, for e.g. Low lying areas, marshy places, areas requiring deep cutting, etc.2. Traffic: The alignment should suit the traffic growth and its impact should be studied carefully and the alignment should pass the thickly populated areas.3. Geometric Designs: The gradient must not exceed the permissible limits and the curves from economical point of view should be of maximum possible radii.4. Topography of Area According to topography, the alignment of a track may be	1M	
			1 Mark each (any three)	4M



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	b) ii) Ans.	<p>classified as:</p> <ol style="list-style-type: none">Valley Alignment: If the two terminal points lie in the same valley then the straight shortest alignment may be chosen without any difficulty and a uniform rate of gradient may be adopted.Cross Country Alignment: In such type of alignments, the water sheds of two or more streams of different sizes have to be crossed and it is not possible to give a uniform grade to the track. Thus, the routes in cross country have sags and summit in succession.Mountain Alignment: The main object in railway alignment is to keep the track as straight as possible. In mountainous region it is achieved by increasing the length of the track keeping the gradient upto the limit of ruling gradient. <p>5. Economic Consideration The alignment should also be economical. The initial cost, cost of maintenance and vehicle operation cost should be taken into consideration.</p> <p>6. Other consideration From drainage point of view, marshy tracks should be avoided. The alignment should be such that the excessive cutting of the rock is avoided. Cutting in snowfall areas should be avoided as it will create problem of cleaning the track in cold season</p>		
	iii) Ans.	<p>Draw the plan and Section of Bridge. Label all the parts.</p> <p>(a) Plan</p>		

(1 Mark for diagram and 1 mark for labelling)



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	b) iii) Ans.	 <p>(b) Section</p>	(1 Mark for diagram and 1 mark for labelling)	4M
Q.2	a) Ans.	<p>Attempt any FOUR of the following: Explain with neat sketch coning of wheel.</p> <p>Coning of wheel:</p>  <p>1. The wheels are coned at a slope of 1 in 20 to prevent from rubbing the inside face of the rail head and to prevent Lateral movement of the angle with its. This is known as coning of wheel. The distance between the inside edges of the wheel flanges is generally kept less than the gauge. So there is a gap between the inside edge of flange and the running face of the rail nearly equal to 10 mm on either side gauge and thus the pressure is always maintained at the inner edge of rail due to coning of wheel.</p> <p>2. It will also helps in decreasing the wear and tear of the flanges and the rail.</p> <p>3. Coning also prevents, to some extent, the slipping of the wheels</p>	2M 2M	16M 4M



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	b) Ans:	<p>Explain any four functions of rail fixtures and fastenings.</p> <p><u>Functions of rail fixtures and fastenings:</u></p> <ol style="list-style-type: none">1. To connect rail end together and fixing rails to sleepers in a track2. To secure arrangement between rails and sleepers and rails and rails.3. To join one rail with other rail to maintain continuity of rails fish plates are used.4. To maintain alignment of track both vertically and horizontally.5. Bearing plate protect sleeper from sinking and damage caused by heavy load and increase life of sleepers.6. Bearing plate helps to distribute load over large area of sleeper.7. To fix rail, bearing plates, chairs to wooden sleeper spikes are used.8. To connect fish plates to rail fish bolts are used. they are made from high carbon steel. To withstand shear.	1 Mark each (any Four)	4M
	c) Ans:	<p>Define points and crossing.</p> <p>Points and crossing is the special arrangement provided on rail way track to facilitate trains to be diverted from one track to another.</p>	4M	4M

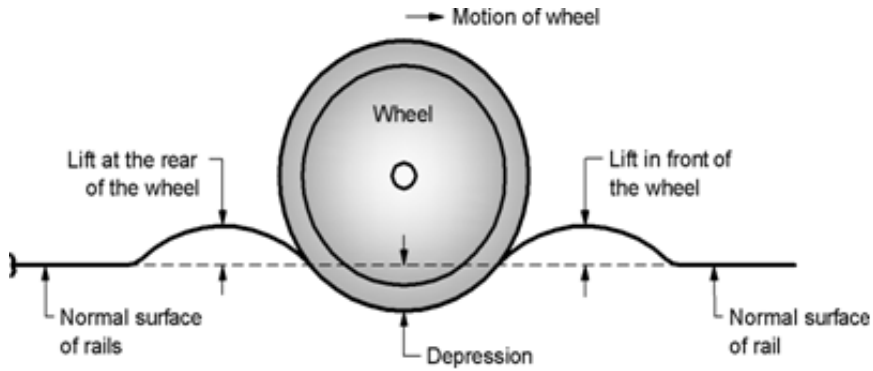


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	d)	What are sleepers in railway engineering and give different functions of sleepers.		
	Ans:	Sleepers: These are the members laid transversely, under the rail for supporting and fixing them at the gauge distance apart are known as sleepers. Function of sleepers: <ol style="list-style-type: none">1. They maintain alignment of track2. They hold rails in proper gauge firmly and evenly.3. They distribute load over large area of ballast.4. They absorb vibrations caused by train, they will act as an elastic medium between rails and ballast.5. They not only support rails but they also helps in maintaining proper super elevation on curves.6. They provides overall stability to the track.	1M	
	e)	State the factors affecting selection of site of a bridge.		
	Ans:	Factors affecting bridge site are as follows- <ol style="list-style-type: none">(1) Width of river : 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.(3) Foundations : The nature of soil at bridge site should be such that good sound foundations should be available at reasonable depth.(4) Connections with roads : 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(6) Materials and labour :<ul style="list-style-type: none">• The site of the proposed bridge should be such that labour, construction material should easily available nearby site.• This type of bridge site will provide economy in the overall cost of construction.	1 Mark each (any Three)	4M



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	e)	<p>(7) Right angle crossing :</p> <ul style="list-style-type: none">• 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. <p>(8) Velocity of flow : The velocity of flow at bridge site should be between the range of non - silting and non-scouring.</p> <p>(9) Scouring and silting : There should be no scouring and silting at bridge site, which will result in minimum maintenance cost</p> <p>(10) Minimum obstruction to water way : There should be minimum obstruction to natural water way at the site of bridge.</p> <p>(11) Sound, economical and straight approaches :</p> <ul style="list-style-type: none">• 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. <p>(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.</p> <p>(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 purpose</p>	<p>1 Mark Each (Any four)</p>	<p>4M</p>
	f) Ans:	<p>Define wing wall. State the functions of wing wall. Enlist different types of wing walls.</p> <p><u>Wing wall:</u> 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. These are provided at both ends of the abutments to retain the earth filling of the approach road.</p> <p><u>Functions of wing wall:</u></p> <ol style="list-style-type: none">1. To protect earth banks from the action of water2. To provide smooth enter in to bridge site.3. To support and protect embankment.	<p>1 M</p> <p>1 ½ M</p>	<p>4M</p>



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	f)	<p><u>The different types of wing walls :</u></p> <ol style="list-style-type: none">1. Straight Wing Walls2. Return Wing Walls3. Splayed Wing Walls	1 ½ M	16M
Q.3	a)	<p>Attempt any TWO of the following.</p> <p>Explain creep of rails. State principal causes of creeps. How creep can be prevented?</p> <p>Ans: <u>Creep of rail-</u></p> <p>Creep in rail is defined as the longitudinal movement of the rails in the track in the direction of motion of locomotives. It is also called as travel of rails. Creep is common to all railways and its value varies from almost nothing to about 6 inches or 16 cm.</p> <p><u>Principal causes of creeps-</u></p> <p>1. Wave action or Wave Theory:</p> <p>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.</p>  <p>2. Percussion Theory:</p> <p>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.</p>	2 M	
			1 Mark each (any four)	

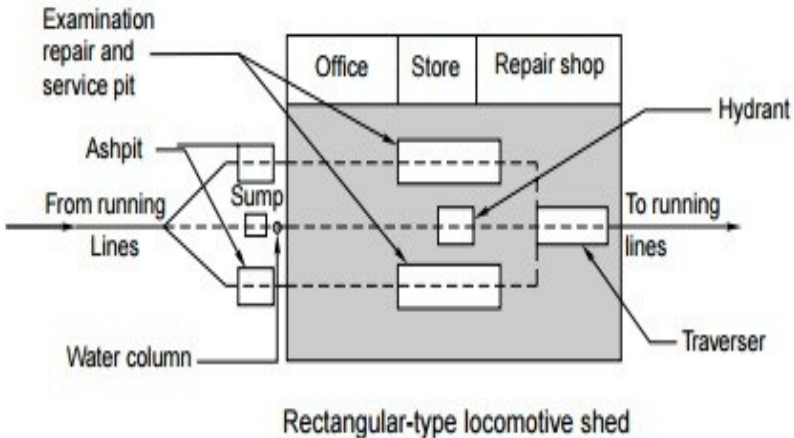


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	a)	<div style="text-align: center;"> </div> <p>3. Accelerating or Starting of a train: At the time of accelerating or starting of a train, the engine wheels give a backward thrust which tends to push the rails backwards, causing creep in the backward direction.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>7. Alignment of the track: Creep is greater on curved portion than on straight portion of the track.</p> <p>8. Gradient of the track: Creep is more on a track with steep gradient, particularly, if the trains move downwards with heavy loads.</p> <p>9. In addition to this, creep may also cause due to following reasons</p> <ul style="list-style-type: none"> • Improper consolidation of formation bed of track. • Insufficient number of ballast is laid. • Improper packing of ballast. <p>Creep Prevention:</p> <p>Pulling back the rails:</p> <ol style="list-style-type: none"> 1) Using crow bars and hooks through fish bolt holes 2) Provide sufficient ballast and packing with care. <p>Use of steel slippers:</p> <ol style="list-style-type: none"> 1) steel through sleepers are best 2) Increase in number of sleepers can help. 	2M	8M



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	a)	Using Anchors/Anti-creepers: 1) 4 anchors per rails if creep is 7.5cm to 15cm/month. 2) 6 anchors per rail if creep is 22.5 to 25cm/month. 3) Used at levels crossings, in yards and places of heavy brake application		
	b)	State points to be considered while selection of site for Railway station.		
	Ans:	Following factors should be considered while site selection for railway station: 1. Drainage The proposed railway station site should be on a fairly leveled ground and it should be well drained. 2. Water Supply There should be plentiful supply for water at the site of station. 3. Future Allowances There should be sufficient land available for the purpose of future extensions along both sides 4. Gradient The site should be such that permissible maximum gradients can be obtained without much difficulty. The vehicles may start moving with wind which is very hazardous. 5. Location or Horizontal Alignment The location of station yards should be such that it is neither located neither near a curve nor on a curve. 6. Vertical Alignment The train should not be situated in sag but it should be on a summit. 7. Accessibility The station yards should be such that it is easily accessible from city or town. There should be well developed and efficient transportation system which leads the people and their goods to station with much ease. 8. Visibility The environment around the site selected for a station should be such that their exists clear and improved visibility for the drivers of trains. There should be certain enough arrangements made which improvements made which improves the visibility of a station. 9. Facilities The site selected for the station should be such that for the passengers of trains, machinery works, garages, workshops etc	1 Mark each (Any Eight)	8M

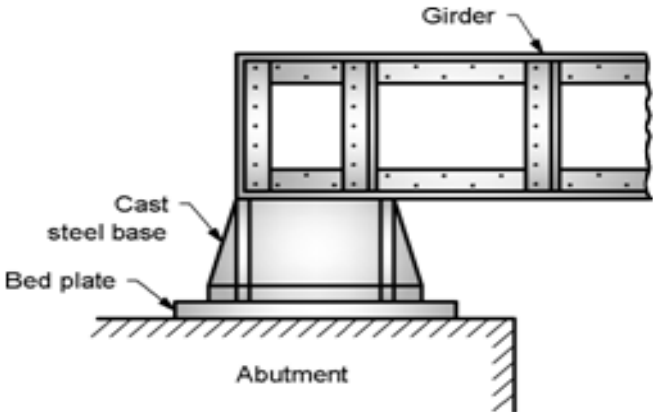
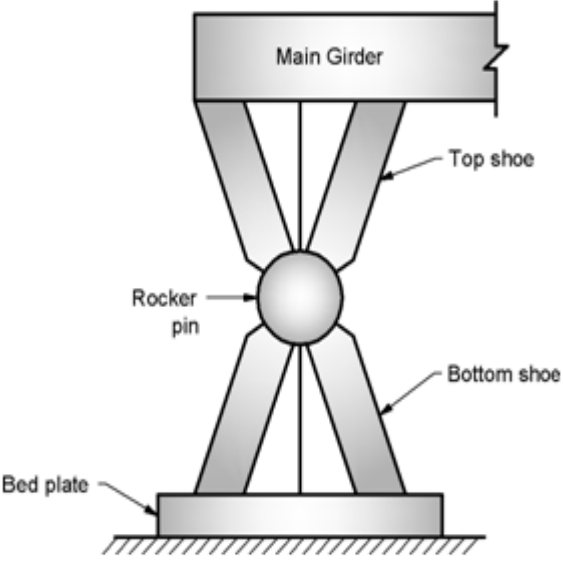


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	c)	<p>Explain the purpose of locomotive yards. State the requirements of locomotive yards. Draw the Layout of Rectangular Locomotive Yards.</p> <p>Ans: <u>Purpose of locomotive yard</u></p> <p>1) Purpose of locomotive yard is for proper arrangements of supply of fuel and water.</p> <p>2) Arrangements for cleaning, examining, inspecting and maintaining the locomotives.</p> <p><u>Requirement of locomotive yards</u></p> <ol style="list-style-type: none"> 1. Should be located near the passenger and goods yards 2. Water column should be provided. 3. Engine shed, Ash pit, inspection pit, repair shed, turn table should be provided. 4. Hydraulic jack for lifting operations should be provided. 5. Over head tank and loco well should be provided. 6. Sick siding should be provided. 7. Place for future expansion should be provided. <p><u>Layout of Rectangular locomotive Yards:</u></p> 	1M	8M
Q.4	a)	<p>Attempt any TWO of the following.</p> <p>State the function of bridge bearing. State the types of bridge bearing and explain any one.</p> <p>Ans: <u>Function of bridge bearing:</u></p> <ol style="list-style-type: none"> 1) Bridge bearings are structural equipment or devices installed between bridge substructure and superstructure to transfer the applied load including earthquake loads, wind loads, traffic loads, and superstructure self-weight. 2) Bridge bearings also make rooms for relative movements between superstructure and substructure, for instance, rotation movements and translational movements in horizontal and transverse direction. 	4M	16M

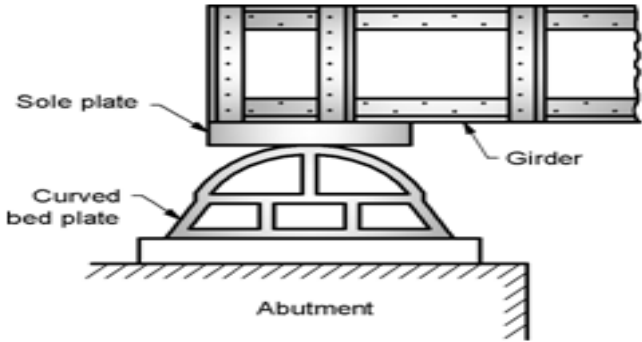
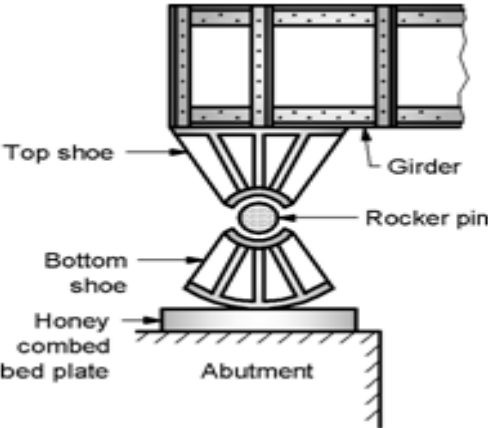
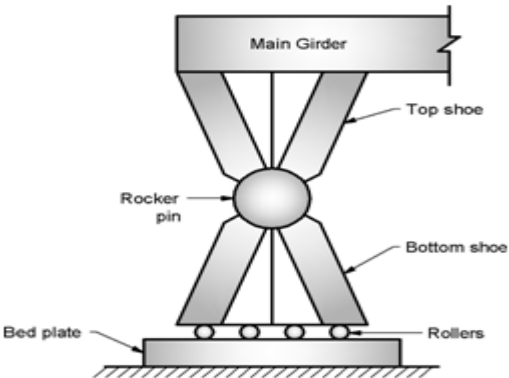


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	a)	<p style="text-align: center;">Or</p> <ol style="list-style-type: none">To distribute the load received over large area.To allow for longitudinal expansion or contraction due to changes in the temperature.To allow for angular movement at support due to deflection of girders.To allow for vertical movement due to sinking of supports.To transfer horizontal forces occurring due to application of brakes to the vehicle etc.To keep the compressive stress within safe limits. <p><u>Types of Bearing:</u></p> <p>A. Fixed Bearing:</p> <ol style="list-style-type: none">Fixed Plate BearingDeep Base BearingRocker BearingKnuckle Bearing <p>B. Expansion Bearing:</p> <ol style="list-style-type: none">Sliding Plate BearingDeep cast with curve plateRocker bearing with curved baseRocker & roller bearing <p>1) Fixed Plate Bearing: This is the simplest type of fixed bearing. It consists of flat rectangular Steel plate attached to the underside of the lower flange of the girder. This type of bearing is suitable for span of bridge up to 12m.</p> <div style="text-align: center;"><p>The diagram illustrates a fixed plate bearing. A horizontal girder is shown resting on a rectangular bearing plate. This bearing plate is supported by a larger bed plate, which is in turn supported by an abutment. Labels with arrows point to the Girder, Bed plate, Bearing plate, and Abutment.</p></div>	4M	8M
			2 Mark (any one)	

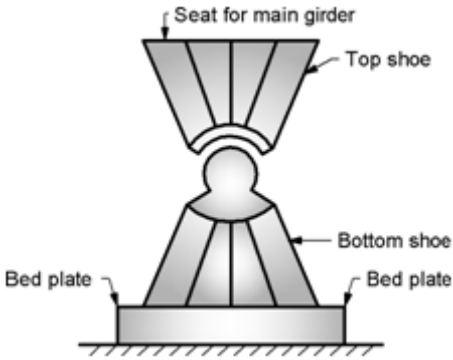
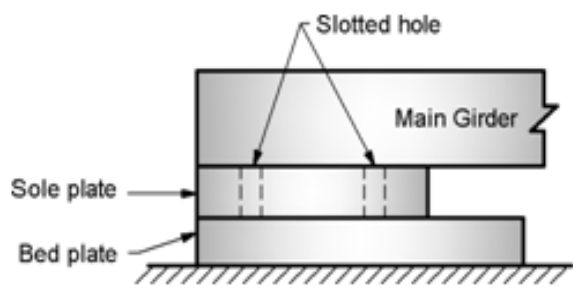
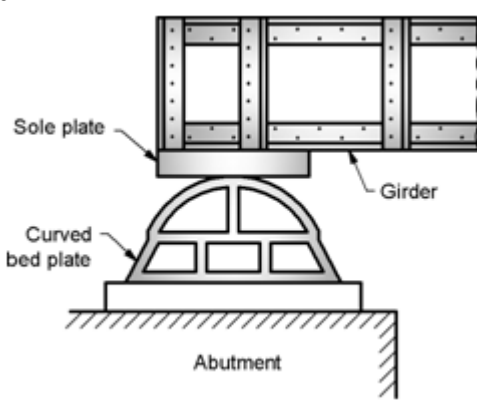


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	a)	<p>2) Deep Based Bearing: This is an important form of shallow of fixed plate bearing. This type of bearing is suitable for 12 to 20 m span. This type of bearings avoids the concentration of reaction at the inner edge of bearing.</p>  <p>3. Rocker Bearing This type of bearing consists of top inverted shoe & a bottom with a rocker pin provided in between the shoe. This type of bearing is suitable for long span over 80 m. This bearing allows only free angular movement of the main girder.</p> 		



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	a)	<p>2. Deep cast with curve plate</p> <p>This type of bearing consists of a sole plate which is attached to underside of bridge girder. This type of bearing is suitable for span 12 to 20 m.</p>  <p>The diagram shows a cross-section of a bridge girder resting on an abutment. A sole plate is attached to the underside of the girder, which is supported by a curved bed plate on the abutment.</p> <p>3. Rocker bearing with curved base</p> <p>This is a type of rocker bearing but in this bearing, bottom shoe is provided with curved bottom which offers minimum resistance to the longitudinal movement of the bridge girder. This type of bearing is suitable for span 12 to 20 m.</p>  <p>The diagram shows a cross-section of a bridge girder resting on an abutment. The girder is supported by a top shoe, which is connected to a rocker pin. The rocker pin is supported by a bottom shoe, which is connected to a honey combed bed plate on the abutment.</p> <p>4. Rocker & roller bearing</p> <p>This type of bearing consists of rocker bearing having its bottom shoe resting on a number of steel rollers which in turn roll on a honey combed bed plates is anchored to the top of masonry of abutment. This type of bearing is suitable for span more than 20 m. This type of bearing allows for free longitudinal as well as angular movements of the bridge girder.</p>  <p>The diagram shows a cross-section of a bridge girder resting on an abutment. The girder is supported by a top shoe, which is connected to a rocker pin. The rocker pin is supported by a bottom shoe, which is connected to a bed plate. The bed plate is supported by a number of steel rollers, which in turn roll on a honey combed bed plate on the abutment.</p>		



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	a)	<p>4. Knuckle Bearing</p> <p>This type of bearing, rocker pin is eliminated by casting the top of the bottom shoe in the shape of a hemisphere to function as rocker pin. This type of bearing is suitable for long span bridge up to 20m. The knuckle bearing is adopted when it is desired to provide only for angular movement of the girder which is fixed to the top shoe.</p>  <p>B. Expansion Bearing:</p> <p>1. Sliding Plate Bearing</p> <p>Sliding Plate Bearing-This is the simplest type of expansion bearing. It consists of a sole plate attached to the main bridge girder, which is free to slide over the wall plate, anchored to the masonry abutment. This type of bearing is suitable for span 12 to 20 m.</p>  <p>2. Deep cast with curve plate</p> <p>This type of bearing consists of a sole plate which is attached to underside of bridge girder. This type of bearing is suitable for span 12 to 20 m. This type of bearing is useful to allow free angular movement of the main girder.</p> 		

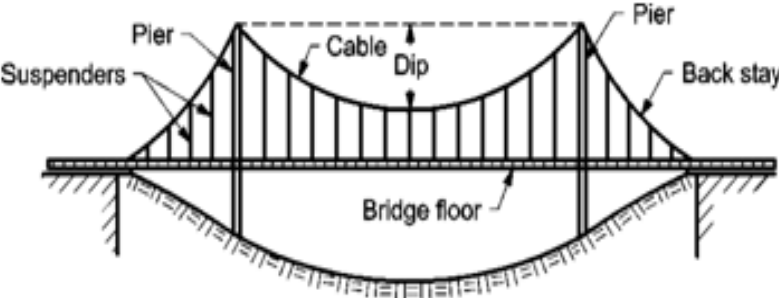
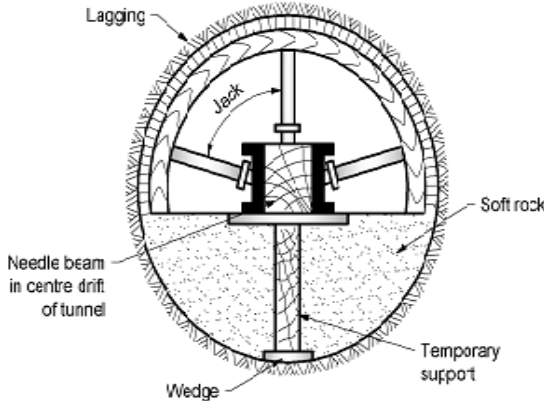


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	a)	<p>3. Rocker bearing with curved base This is a type of rocker bearing but in this bearing, bottom shoe is provided with curved bottom which offers minimum resistance to the longitudinal movement of the bridge girder. This type of bearing is suitable for span 12 to 20 m.</p> <p>4. Rocker & roller bearing This type of bearing consists of rocker bearing having its bottom shoe resting on a number of steel rollers which in turn roll on a honey combed bed plates is anchored to the top of masonry of abutment. This type of bearing is suitable for span more than 20 m. This type of bearing allows for free longitudinal as well as angular movements of the bridge girder</p>		

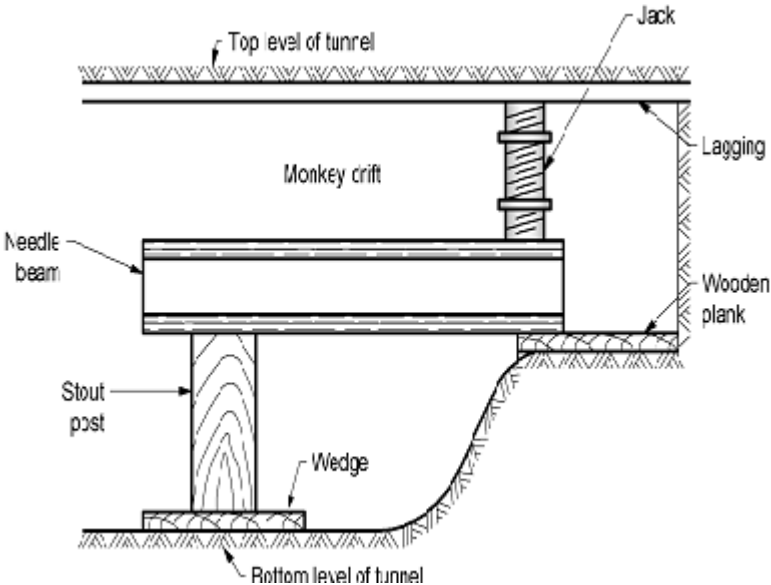
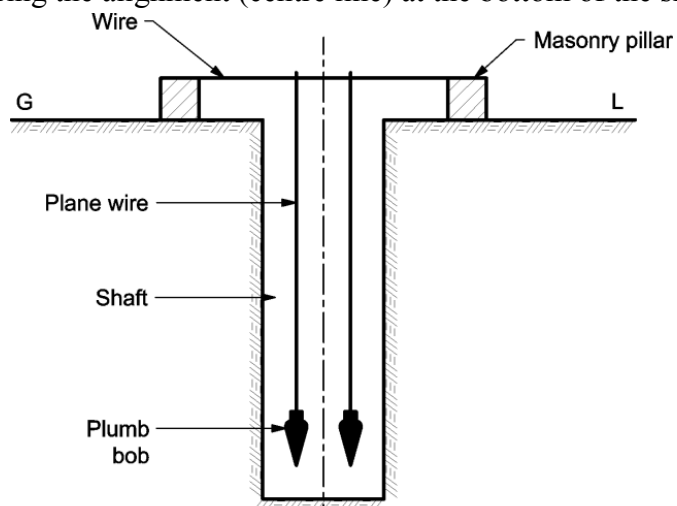
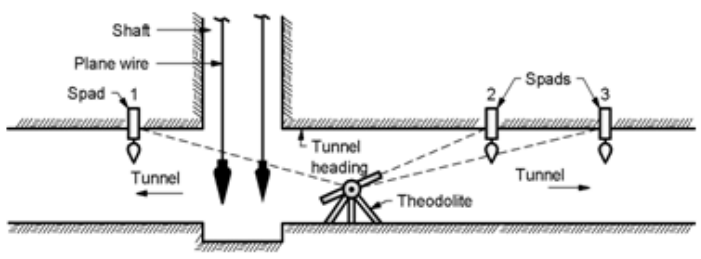


Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	b) Ans.	<p>State functions of Abutments and states the requirements of good abutments.</p> <p><u>Functions of abutment :</u></p> <ol style="list-style-type: none">1. To retain the earth pressure of embankment of the approaches.2. To support the bridge superstructure and to transmit the load from it to the subsoil lying underneath.3) To finish up bridge so that it can be put for use./ To provide final formation level to the bridge superstructure4) To transmit the reaction of superstructure to the foundation. <p><u>Requirements of good abutments:</u></p> <ol style="list-style-type: none">1) It should be cheaply and easily constructed.2) It should be durable.3) It should be having pleasing appearance.4) It should be have less maintenance cost.5) It should transmit load to foundation.6) It should take load of superstructure.7) It should be stable against soil erosion.8) It should be capable to withstand earth pressure of embankments of approaches.9) It should have sufficient bearing area.	<p>1 Mark each</p> <p>1 Mark each (Any Four)</p>	8M
	c) Ans.	<p>Explain suspension bridge with neat sketch. State its advantages and disadvantages.</p> <p><u>Suspension bridge:</u> - The bridge consisting of two or more cables hanging in a curve, which supports the roadways, are known as suspension bridges. They are used where it is difficult to adopt other type of bridges they are economically used for every large span.</p> <p>These are single span bridges having two main cables on each side of roadways. They are carried over solid piers and are securely anchored to the banks. The road way is suspended from two main cables by means of suspenders. Sometime two sides span are added besides the main central span.</p> <p>The side spans rest either over a separate supported system or suspended from the back stays. Suspension bridges are not rigid the dip is usually taken as 1/10th of span.</p> <p><u>The Advantages of Suspension Bridges</u></p> <ol style="list-style-type: none">1. Cost effective and economical in construction.2. Can be built up to great heights.3. Spans great lengths.4. Has flexibility for wind pressure and earthquake.5. Simple in construction	<p>2M</p> <p>1 Mark each (Any Two)</p>	



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	c)	<p><u>Disadvantages of Suspension Bridges</u></p> <ol style="list-style-type: none"> Needs extensive foundation work for soft ground. Too flexible for high speed winds. Cannot support high traffic as very less support is available for deck. Cannot withstand heavy load. <p><u>Sketch of suspension bridge</u></p> 	<p>1 Mark each (Any Two)</p> <p>2M</p>	<p>8M</p>
Q.5	a)	<p>Attempt any <u>TWO</u> of the following:</p> <p>Explain Needle Beam Method with a neat sketch, also state its advantages.</p> <p>Ans. <u>Construction steps:</u></p> <ol style="list-style-type: none"> About 1 x 1m small drift is prepared on the working face of tunnel Roof of drift is supported on lagging provided on wooden segments which are carried on the trench jacks as shown in figure below. The needle beam is placed horizontally whose front end rests on drift and the rear end is supported on vertical stout post. After excavation, the lining is provided to the tunnel section and mucking is done. <p><u>Advantages of needle beam method :</u></p> <ol style="list-style-type: none"> This method is economical. Brick lining can be easily done by this method. Needle beam forms the main temporary support during the excavation 	<p>2M</p> <p>1 Mark each (any Two)</p>	<p>16M</p> <p>8M</p>
				



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	a)		4 M	
	b)	<p>With the help of neat sketch explain the procedure of transferring the centre line inside the tunnel.</p>		
	Ans.	<p>Transferring the alignment (centre line) at the bottom of the shaft</p> 	2M	
		<p>Transferring the alignment to inside of the Tunnel</p> 	2M	8M



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	b)	First of all shaft is constructed. After construction of shafts, the center line of tunnel is to be transferred down the shafts. For this purpose, generally two small pillars are constructed on opposite edges of the shaft along the center line of the tunnel. On the top of pillars, the points corresponding to the centre line are correctly marked and a wire is then stretched between them. After this two plumb bob are suspended inside the shaft as shown in figure above. Two points are then marked by lowering plumb bob to the bottom of the shaft. The line joining the two points represents the center line of the tunnel marked on the ground. These lines above. are further extended into the tunnel heading as the work advances, by a theodolite placed in the shafts. Points along the centre line are marked by a peg provided with plumb bobs (spades), fixed to the roof of the tunnel as shown in figure.	4M	8M
	c)	Mention Various explosives used in tunneling .What precautions you will ensure while explosions?	4M	
Ans.	Explosives used in tunneling are mainly classified into the following categories: 1. Power explosive 2. Disruptive explosive 3. Liquid air Power explosive: Some common powers explosive are Blasting powder, Nitrate explosive, Nitra man. Disruptive explosives: such type of explosive used in the form of cartridge of size 2.5 cm to 20 cm in diameter and 20 cm to 70 cm in length. Some common disruptive explosives are straight dynamite, Ammonia dynamite, Gelatin dynamite , semi gelatin , Blasting gelatin Liquid air : These explosive consists of 95 % oxygen at temperature of 191 ⁰ c, which is absorbed by dipping a cartridge of absorbent. This cartridge acts as a liquid explosive. Such explosive require special skill in their manufacture, transporting and storing. Precautions: (1) Blaster must ensure those explosives are handled in accordance with the manufacture's instruction. (2) Blaster must ensure those explosives are protected from impact and rough handling. (3) It is ensure that no persons primes a charge in an area where explosive are stored. (4) A Persons must not carry an explosive in clothing. (5) A blaster must ensure that an electric detonator is kept shunted or short – circuited, except during the testing or use of the detonator.	1 Mark each (any Four)		



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	a)	Attempt any <u>FOUR</u> of the following: What is the necessity of tunnel ventilation?		16M
	Ans.	<u>Necessity of tunnel ventilation:</u> 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.	1 Mark each	4M
	b)	List the commonly used drilling machines in tunneling.		
	Ans.	Drilling equipment's are divided into two types (a) Drill (b) Drill carrying equipments (a) Drill: The mechanical devices used for drilling holes in the tunnels heading are known as drills. The common Drills used are - 1) Jack Hammer 2) Drifters 3) Tripod drills 4) Stop hammers 5) Stop hammers 6) Well drills 7) Piston drills 8) Wagon drills (b) The following equipment is required for carrying the drills 1) Support for mounting drills 2) Drill carriage 3) Drill jumbo (c) Tunnel boring Machine 1) Soft rock 2) Hard rock	1M 2M 1M	4M
c)	What is shaft? State the purpose of providing shaft.			
Ans.	<u>Definition:</u> The vertical wells or passages constructed along the alignment of a tunnel are known as shafts. <u>Purpose of providing shaft</u> 1) To provide opening for removal of muck. 2) To expedite the construction work of the tunnel by starting excavation at several points at the same time. 3) To provide passageway for pumping out the water from the tunnel. 4) To provide natural ventilation during construction of the tunnel.	1M 1 Mark each (any Three)	4M	
d)	State classification of Tunnels.			
Ans.	<u>Classification of Tunnels are as follows:</u> a. According to the purpose: 1) Traffic tunnel: Railway tunnels, Highway tunnel, Pedestrian tunnel, Navigation tunnel, Subway tunnels 2) Conveyance tunnel: Hydro power tunnels, water supply tunnel, sewage tunnel, tunnels for industrial use.	1M		



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	d)	<p>b. According to the type of materials: Tunnels in hard rock, Tunnels in soft rock, Tunnels in quick sand, Tunnels under river bed</p> <p>c. According to the position of alignment: Saddle and base tunnels, Spiral tunnels, Off spur tunnels, Slope tunnels</p> <p>d. According to Shape and Size of Tunnels: Rectangular or box type shape, Circular shape, Segmental shape, Horse shoe shape, Egg type shape, Elliptical shape, Poly –centric shape</p>	1M 1M 1M	4M
	e) Ans.	<p>Explain with sketch, effective span, Clear span, economical span and waterway of bridge.</p> <p>1. Effective span: The center to center distance between any two adjacent supports of the bridge superstructure is called effective span.</p> <p>2. Clear span: The clear distance between two adjacent supports of the bridge superstructure is called clear span.</p> <p>3. Waterway of bridge: It is the area of opening, which should be sufficient to pass the maximum flood discharge that would ever parts under bridge, without increasing velocity to a dangerous limit.</p> <p style="text-align: center;">OR</p> <p>The sectional area at the site of a bridge through which water flows is termed as waterway.</p> <p>4. Economical span: The span for which the total cost of the bridge is minimum is known as economical span of a bridge.</p>	1/2 Mark each	4M
			2M	



Que. No.	Sub. Que.	Model Answers	Marks	Total Marks									
Q.6	f) Ans.	Compare RCC bridges with steel bridges with respect to construction and maintenance.	2M 2M	4M									
		<table border="1"><thead><tr><th>Type of work</th><th>R.C.C. Bridge</th><th>Steel Bridge</th></tr></thead><tbody><tr><td>Construction</td><td>Construction is more strong and durable. It requires more time to construct.</td><td>Construction is more strong but it is not durable. It required less time to construct.</td></tr><tr><td>Maintenance</td><td>Maintenance is less It resists corrosion therefore painting is not required.</td><td>Maintenance of steel bridge is more. It requires periodical painting to avoid corrosion.</td></tr></tbody></table>			Type of work	R.C.C. Bridge	Steel Bridge	Construction	Construction is more strong and durable. It requires more time to construct.	Construction is more strong but it is not durable. It required less time to construct.	Maintenance	Maintenance is less It resists corrosion therefore painting is not required.	Maintenance of steel bridge is more. It requires periodical painting to avoid corrosion.
		Type of work			R.C.C. Bridge	Steel Bridge							
Construction	Construction is more strong and durable. It requires more time to construct.	Construction is more strong but it is not durable. It required less time to construct.											
Maintenance	Maintenance is less It resists corrosion therefore painting is not required.	Maintenance of steel bridge is more. It requires periodical painting to avoid corrosion.											