

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous) (ISO/IEC - 27001 - 2005 Certified)

Model Answer: Summer 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.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	a) (i)	Attempt any <u>SIX</u> of the following: State role of transportation in development of India.		12
	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. 	1 each (any two)	2
	(ii) Ans.	 Enlist two characteristics of road transport. 1) They provide door to door service. 2) It is ideal for non-bulk cargo especially passenger and freight. 3) They transport men and material from one part to other speedily and easily. 4) Starting and destination points need not be necessarily defined unlike in other modes of transport. 5) In hilly or mountainous region roads are the only means of conveyance. 6) Help to provide medical aid to remote places. 	1 each (any two	2



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Q. 1	(iii) Ans.	Define gradient and crossing. Gradient: The rate of rise or fall provided to the formation of railway track along its alignment is known as gradient or grade.	1	2
		Crossing: The arrangement by which different routes either parallel or diverging from the first track are connected to facilitate the diversion of train from one track to another track without any obstruction are known as points and crossings.	1	
	(iv) Ans.	 State any two duties of Ganger. 1) The ganger is the in-charge of the gang and is personally responsible for the safety and upkeep of the track of his section. 2) He should arrange the tools, equipment etc. required by his gang. 3) He should keep his section in good running condition at all times. 4) He should maintain the correct gauge of the track. 5) In case of accident, he should look after the broken track components and rolling stock and should ensure that they are not disturbed unless they are inspected by competent authority. 	1 each (any two	2
	(v) Ans.	 Enlist various modes of transportation. The various modes of transportation system are as follows- Roadways Railways Waterways Airways 	¹ / ₂ each	2
	(vi) Ans.	Define superstructure and substructure of bridge. Superstructure : The upper part of bridge consisting of structure system in the form of beams, girders, arches, suspension cables etc. carrying the communication route is called superstructure. Substructure: The lower part of bridge consisting of structure system in the form of abutment, piers, wing wall etc. along with their foundation which support superstructure is called substructure.	1	2
	(vii) Ans.	 State 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.	 State any two advantages of tunnel. 1) Tunnel connects the two terminal stations of shortest roots. 2) Tunnel provides free movement of traffic throughout the year even during snow fall and landslide. 3) Tunnel facilities conduction of water to generate the power. 4) Tunnel helps in avoiding acquisition of costly land and property for railway or road projects. 	1 each (any two	2



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Q. 1	b)	Attempt any <u>TWO</u> of the following :		8
	(i) Ans.	 State causes and effects of creep of rail. Causes of creep of rail: Ware action. Percussion theory. Accelerating and starting of train. DE accelerating or stopping the train. Intensity of traffic. Alignment of track. Gradient of track. Expansion and contraction of rails due to variation in temperature. Effects of creep of rail: Sleepers moves out of position affecting the gauge and align. The rail joints are jammed and prevent expansion. Operation of switches becomes difficult. 	¹ / ₂ each (any two) 1 each (any two)	4
	(ii)	4) The surface of track is disturbed, results in uncomfortable riding. Draw sectional elevation of Bridge Show all components		
	Ans.	Bridge floor Approach Railing Bearing Bearing H.F.L Substructure Substructure Free Pier Pier Pier Pier Pier Pier Abutment	4	4
	(iii) Ans.	 (Note: 3marks for sketch and 1mark for labeling) State necessity of bridge maintenance. 1) After any bridge is constructed and open to traffic, its components such as foundation, abutment, piers, flooring system, railing etc. are subjected to damage due to one or other reason. 2) Unless constant and proper upkeep of these bridge components are not made, they are liable to damage and may endanger the safety of the bridge structure. 3) Poor design and construction may result in worst problem for bridge maintenance even if the bridge is well design and constructed with periodic maintenance. However the extent of maintenance depends upon the bridge site. 4) Moreover the useful life of bridge is much reduced due to improper or faulty maintenance. 	1 each	4



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Q. 2	2	Attempt any <u>FOUR of the following</u> :		16
	(a) Ans.	 Write factors affecting rail alignment. Factors governing the rail alignment are as follows Obligatory Points: Alignment of track has to be deviated from straight line because it has to pass through obligatory points like market places, educational centers, etc. Certain undesirable locations have to be avoided, for e.g. Low lying areas, marshy places, areas requiting deep cutting, etc. Traffic: The alignment should suit the traffic growth and its impact should be studied carefully and the alignment should pass the thickly populated areas. Geometric Designs: The gradient must not exceed the permissible limits and the curves from economical point of view should be of maximum possible radii. Topography of Area: According to topography, the alignment of a track may be classified as: a) 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. b) Cross Country Alignment: In such type of alignments, the watersheds 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. c) 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 up to the limit of ruling gradient. d) Economic Consideration: The alignment should also be economical. The initial cost, cost of maintenance and vehicle operation cost should be taken into consideration. e) 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. <td>1 each</td><td>4</td>	1 each	4
	(b) Ans.	What is Marshalling yard? State its functions and different types. Marshalling yard: The yards where trains and other loads are received, sorted out stations wise and new trains are formed and dispatched onwards are known as Marshalling yard.	1	
		 The functions of a marshalling yard are as follows: 1) Reception of empty and loaded wagons. 2) Sorting of wagons. 3) Departure of wagons in the forms of trains. 4) New trains are formed and dispatched. 5) Distribution centre for trains. 	11/2	



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Q. 2		Types of Marshalling yard are:		
		 Flat yards Gravitational yards Hump yards 	11⁄2	4
	(c) Ans.	 State any four necessities of periodic track maintenance. 1) Due to weathering effects, the wear and tear of track component is likely to take place. 2) The new track may be 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 crossings on curves there might be chances of deterioration due to high speed and heavy wheel loads of different parts of track. 4) The track structure has to bear loads on curve, points and crossings, approaches and crossings. 	1 each	4
	(d) Ans.	Define bridge alignment and two types of bridge alignment. Definition: The position occupied by the center line of a bridge in plan is called bridge alignment.	2	
		Types of bridge alignment:		
		1) Square alignment: In this, the bridge is at right angle to the axis of the river. It is also called as Straight alignment.	1	4
		2) Skew alignment: In this, the bridge is at some angle to the axis of river which is not a right angle.	1	
	(e) Ans.	 Write any four functions of bridge 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



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Q. 2	(f)	Compare	Compare permanent and temporary bridges.					
	Ans.	Sr. No.	Points of comparison	Permanent bridge	Temporary bridge			
		1	Initial cost	Initial cost is high	Initial cost is low			
		2	Structural forms	These bridges are simple as well as complex in their structural forms.	These bridges are simple in their structural forms.			
		3	Skill required on construction	More skill required for construction	Less skill required for construction		1 each (any four)	4
		4	Time required in construction	Require more time in construction	Require less time in construction			
		5	Load carrying capacity	These bridge can take heavy loads	These bridge can take light loads			
		6	Construction	Difficult in construction	Easy in construction			
		7	Suitability to traffic	Suitable for heavy traffic	Suitable for light traffic			
		8	Maintenance cost	High	Low			
Q. 3	(a) Ans.	Attempt Draw lind diamond Scissor ch	Iterative Incarve frame Ingit traine 8 Maintenance cost High Low Attempt any TWO of the following : Draw line sketches of points and crossings – scissor cross over and diamond crossing. Scissor cross over : Scissor cross over : Scissor Cross Over Scissor Cross Over Kote: 3marks for sketch and 1mark for labeling)					16



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Q. 3	- Que	Comparison betwee	en meter gauge, broad	gauge and narrow		1,101115
		gauge :				
		Broad gauge	Meter gauge	Narrow gauge		
		width 1676 mm	width 1000 mm	width 762 mm and 610		
				mm		
		Suitability 1) When	1) When the funds	Suitability 1) When the		
		sufficient funds	available for the	construction of as track		
		are available for	railway projects are	with wider gauge		
		the railway	inadequate.	prohibited due to the	4	8
		projects.		curves, steep gradients.		
				narrow bridge, and		
				tunnel etc.		
		2) When the	2) When the	2) When the prospects		
		prospects of	prospects of	of revenue are not so		
		revenue are very	revenue are not very	bright.		
		bright.	bright.			
Q. 4		Attempt any <u>TWO</u>	of the following :			16
	(a)	Explain eight facto	rs affecting selection of	of site of bridge with their		
		importance.	fact calaction of site of	hridaa .		
	Ans.	(1) Width of river :	lect selection of site of	onuge.		
		The smaller the widt	th of river, the cheaper	will be the bridge in its		
		initial cost as well as	s maintenance cost.			
		(2) A straight reach The river should hav	e straight reach over a	reasonable long distance		
		on upstream side and	d downstream side of th	he bridge site so that the		
		utility of bridge can	be maintained for the d	esign period.		
		(3) Foundations : The nature of soil at	bridge site should be si	ich that good sound		
		foundations should b	be available at reasonab	le depth.		
		(4) Connections with	th roads :			
		I he approaches at the	e bridge site should be	such that they do not		
		(5) Firm embankm	ents :			
		The embankment at	bridge site should high	, permanent, straight, solid		
		and firm. Such emba	inkments will not get d	isturbed at the time of rse of stream to alter		
		(6) Materials and la	abour :			
		• The site of the prop	posed bridge should be	such that labour,		
		• This type of heids	I should easily availabl	e nearby site.		
		• This type of bridge construction.	e site will provide econo	omy in the overall cost of		



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Que. No.	Sub. Oue.	Model Answers	Marks	Total Marks
Que. No. Q. 4	Sub. Que.	 Model Answers (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. (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 : 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. 	Marks 1 each (any eight)	Total Marks
	(b) Ans.	 Sufficient field bound and be available for the passage of bouns, ships under the bridge superstructure if the river is used for navigation purpose. Explain any four types of bridge foundations along with its suitability and sketches. Depending upon the nature and depth, bridge foundations of different categories are of the following types; Spread or Open foundation Raft foundation Grillage foundation Inverted Arch foundation Pile foundation Well foundation Caisson foundation Spread foundation: This type of foundations where the scouring of the river bed is minimum and good hard soil is available within 2 to 3 m below river bed level. This type of foundation can be provided even if the bed contains erodible material as sand, but the scouring is prevented by driving sheet piles on upstream and downstream side and floor pitching. 		



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Q. 4		Inverted Arch foundation Inverted Arch Footing/Foundation is used to be provided for multi- storied buildings in olden times. However, with the advent of reinforced cement concrete construction practice, inverted arch footing is rarely done these days. One of the drawbacks in this type of construction is that the end piles have to be specially strengthened by buttresses to avoid the arch thrust tending to rapture the pier junction. However, the advantage of inverted arch construction is that in soft soils the depth of foundation is greatly reduced. Inverted arch footing has been illustrated below.		
		G.L. www.theconstructioncivil.org Inverted Arch Foundation		
		Pile foundation A pile is basically a long cylinder of a strong material such as concrete that is pushed into the ground to act as a steady support for structures built on top of it. Pile foundations are used in the following situations: When there is a layer of weak soil at the surface. This layer cannot support the weight of the building, so the loads of the building have to bypass this layer and be transferred to the layer of stronger soil or rock that is below the weak layer. When a building has very heavy, concentrated loads, such as in a high rise structure, bridge, or water tank.		
		Column Pile cap GL movement of the cap Pile cap GL GL movement of the cap Hard strata (b) Friction pile GL Pile foundations		



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Q. 4	(c)	Explain functions, requirement and types of piers along with neat		
	Ans.	 sketch. Functions of piers: a. To divide the length of bridge into suitable number of spans. b. To transfer the load from bridge superstructure to subsoil through foundations. 	1 each	
		Requirements of piers: a. It should be easily and cheaply constructed. b. It should involve less maintenance cost. c. It should be constructed of a durable material. d. It should be enough to transfer the load of superstructure to the subsoil lying underneath.	1 each (any two)	
		Types of piers: I. Solid piers: i. Solid masonry piers ii.Solid R.C.C. piers	1	
		 i. Column bents ii. Pile bents iii. Cylindrical piers iv. Trestle piers 	1	
		i. Solid masonry piers		
		Section Elevation		
		(a) A solid masonry pier ii) Solid R.C.C. piers		
		R.C.C. columns R.C.C. web R.C.C. web Section at AA'	1	
		R.C.C. columns		
		Bed Level		
		(b) Dumb-well pier (Solid R.C.C. pier)		
		(Note: Any one sketch from Solid piers 1 mark)		



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Q. 5		Attempt any <u>TWO</u> of the following :		16
	(a) Ans.	 Write a short note on shafts for tunnel. Definition: The vertical wells or passages constructed along the alignment of a tunnel are known as shafts. Purpose of providing shaft. 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. 	2 1 each	8
		 The construction of shaft is completed by the following operation - 1) Drilling and blasting 2) Mucking 3) Timbering 4) Pumping 	¹ /2 each	
	(b) Ans.	 Enlist various operations involved and different methods adopted for tunneling in soft rock. Explain any one method with a suitable sketch. Various operations involved for tunneling in soft rock. 1) Setting up and mining or excavation. 2) Timbering or shuttering the excavated section 3) Mucking i.e. removal of the excavated material. 4) Lining 	2	
		Different methods adopted for tunneling in soft rock. i) Shield method ii) Line plate method iii) Fore-Poling method iv) Needle beam method	2	



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Que. No.	Sub. Que.		Model An	Model Answers			
Q. 5	(c) Ans.	What is in tunn Tunnel on the in	s tunnel lining? State the dif eling with the materials used Lining: A layer of timber, irc nside of a tunnel is known as l	ferent types of linings adopted l. on, masonry or concrete provided ining.	1		
		Type of	tunnel lining with material	used :			
		Sr. No.	Type of tunnel lining	Material used			
		1	Timber lining	Timber			
		2	Stone masonry lining	Stone			
		3	Brick lining	Brick			
		4	Iron lining	Steel	1 each (any	8	
		5	Cast steel lining	Cast Iron	seven)		
		6	Pressed steel plate lining	Steel plate			
		7	Precast block lining	Cement concrete blocks			
		8	Concrete lining	Cement Concrete			
		9	Reinforced concrete lining	Reinforced Cement Concrete			



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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		Attempt any <u>FOUR</u> of the following :		16
	(a) Ans.	Differentiate between flying and floating bridge.		
		Sr. No.Flying BridgeFloating bridge		
		1The bridges consisting of ferry boats or rafts which are usually round or poled across the banks of streams or rivers are known as flying bridge.The bridges having their substructure floating on the water surface of a stream or river known as floating bridge.		
		2Flying bridges are constructed by using suspension cable, by using anchor, by using wrap.Floating bridges are constructed using boat, pontoon and using rafts(Floating mass of wooden logs).	1 each	4
		3 Suitability: A flying bridge is suitable when sufficient funds and materials are not available to make regular bridge over stream or river. Suitability: When it is very costly to provide a permanent bridge over a river having deep water. Military force used such kind of bridge during war days to cross a river.		
		4 Flying bridge can be provided on flowing stream or river. It can be provided for steady flowing perennial river.		
	(b) Ans.	State types of tunnels used for highways and railways with the sketch.		
		Types of tunnels used for highways and railways		
		b) Box shape,		
		c) Horseshoe,		
		d) Oval/Egg.		
		e) Segmental tunnel		



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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		Excavation Cement Concrete Ining Concrete Concrete Ining Concrete Concrete Concrete Concrete Concrete Concrete Concrete Concrete		
		Horse-shoe shape tunnel	1 each (any four)	4
		Oval or egg shape tunnel Excavation Grouting Concrete lining Segmental tunnel		
		Concrete lining Cement grouting Box type tunnel		



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Que. No.	Sub. Oue.	Model Answers	Marks	Total Marks
Q. 6	(d)	State objectives of tunnel ventilation. Enlist methods of tunnel		
	Ans.	 ventilation. Objectives of tunnel ventilation : To supply fresh air inside the tunnel. To remove poisonous gases, dust smoke etc. To reduce temperature in tunnel situated at great depth. By providing ventilation in tunnel which helps to reduce suffocation produce during and after construction of it. 	1 each (any two)	
		Methods of tunnel ventilation : 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 2.Exhausting process 3.Combination of blowing and exhausting process	1 each (any two)	4
	(e) Ans.	Draw box type, circular, segmental shape and horse shoe shape tunnels. Label the part. (1) Box type shape tunnel section		
		Excavation line Concrete lining Cement grouting		
		(2) Circular shape tunnel section		
		Excavation line Cement grouting X Concrete lining		



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Q. 6	_	(3) Segmental shape tunnel section		
		Excavation line Cement grouting Concrete lining	1 each	4
		(4) Horse-shoe shape tunnel section		
		Excavation line Cement grounting X Concrete lining X Concrete		
	(f)	Explain tunnel investigation in detail.		
	Ans.	Tunnel Investigations:		
		The field and laboratory investigations of the area to obtain the necessary subsurface and general data for the safe and economical design and layout of the tunnel are known as tunnel investigation. It includes Geological investigation, Alignment of tunnel and allied consideration, selection of shape and size of the tunnel	1	
		Necessity for tunnel investigation		
		 To locate underground presence of water, fault planes etc, so as to overcome problems which are likely to occur during tunneling. To know the nature and type of strata through which the tunnel is to be drive so as to decide a suitable method of tunneling. Tunnel should pass through the hard rock, as the chances of accidents are much less as compared to soft rock. The alignment should be such that the excavation work is minimum. The alignment should not be near water channel. The portal of the tunnel should be near the dumping yard so that the muck may be disposed of in lesser time. The alignment should be as straight as possible. Minimum possible grade should be provided in tunnel. after considering the above two points its shape and size may be decided, depending upon the nature of ground and purpose for which 	1 each (any three)	4