

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I (CE 653)**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. Discuss the component of transportation system. Explain the different types of urban road patterns. [4+4]
2. Define highway alignment. Explain the factors controlling highway alignment. [2+6]
3. Define overtaking sight distance. Derive an expression for overtaking sight distance with neat sketch. [2+6]
4. Explain momentum grade. Discuss method of providing superelevation. [4+4]
5. A transition curve is to be provided to connect a straight and circular curve of radius 325 m of a two lane road in a hilly terrain with heavy rainfall. Design the length of transition curve assuming suitable data. The design speed of the highway is 60 kmph and rate of introduction of super elevation is to be 1 in 60. Determine the elevations of outer edges at two typical straight and circular curved sections of the road with centre line at elevations of 312.23 m and 312.9 m respectively considering a parabolic camber of 2.5% to be provided. [8]
6. A -3% gradients meets a 1.5% gradient at a chainage of 2000 m and at the reduced level of 500 m if the design speed of the road is 100 km/hr, determine RL and chainage of the tangent points, lowest point on the curve. Assume height of head light is 0.75 m and take frictional coefficient  $f = 0.35$  and  $\alpha = 1^\circ$ . [8]
7. What are the requirements of highway drainage? Explain the surface drainage system. [3+5]
8. Explain why hill road construction is challenging. Sketch different types of hill road cross-sections. [4+4]
9. Define highway material. Discuss the desirable properties of subgrade soil. Explain the laboratory procedure for determining hardness of aggregate. [1+3+4]
10. Enumerate the various types of tests on bituminous binders. Explain the procedure and significance of softening point test. [3+5]

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Exam.	Back	
Level	BE	Full Marks 80
Programme	BCE	Pass Marks 32
Year / Part	III / II	Time 3 hrs.

**Subject:** - Transportation Engineering I (CE 653)

- Candidates are required to give their answers in their own words as far as practicable.
- Attempt All questions.
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- Assume suitable data if necessary.

- Explain the three components of Transportation System. What are the advantage and disadvantage of Railway with respect to road Transportation? [4+4]
- What are the ideal requirement of Highway alignment? Explain the classification of roads as per Nepal Urban Road Standard. [4+4]
- Two approaching cars were caught on head on collision at a vertical summit curve connecting 4% ascending gradient with 3.5% descending gradient. The posted speed on this road is 70 km/hr. The highway engineer checked the geometrics of the road and found that the highest point of the vertical curve lies at the distance of 120 m from the beginning of the vertical curve. Check if the crash is due to fault in posted speed sign. Height of car driver's eye = 1.08 m, reaction time = 2.5 sec, coefficient of longitudinal friction = 0.35. What should be the posted speed if there is fault in posted speed limit sign? [8]
- Describe about the various elements of cross section of urban road along with the sketch of the typical cross section of urban road. [8]
- Define set back distance with factors affecting set back distance. Derive expressions for the setback distance on horizontal curve of single lane and multiple lane roads. [2+6]
- The design speed is 60 kmph and the maximum permissible value of super elevation and coefficient of lateral friction are 0.07 and 0.15. Highway engineer is planning to design super elevation for a curve of radius 150 m. (i) Find out the equilibrium super elevation. (ii) Design the super elevation for this curve. (iii) if the maximum super elevation is not to be exceeded, calculate the maximum allowable speed on this curve. (iv) What would be the ruling radius required if speed of 60 kmph is to be maintained. [8]
- Write down the cause of moisture variation in sub grade soil. Write down the steps of design of side drain in road. [2+6]
- Define Catch drain and its role in hill roads. Explain about any four gully control structures/methods used in hill road? [2+6]
- Define Hardness and Toughness of aggregate along with example of the test to determine Hardness and Toughness. Determine the best proportion of Aggregates A and B given below that will produce an aggregate blend meeting the given specification limits using graphical method. [2+6]

IS Sieve Size (mm)	Percentage passing		Specification limit
	Aggregate P	Aggregate Q	
25.0	100	100	100
19.0	100	95	95 - 100
9.5	80	55	60 - 75
4.75	60	35	40 - 55
2.36	55	15	30 - 40
0.60	25	10	12 - 22
0.075	5	9	3 - 10

Write down the desirable properties of Bitumen. Explain the method of conducting viscosity test in laboratory.

TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2078 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I (CE 653)**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions. .
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1. Explain briefly, the classification of road as per NRs (2070). Discuss Macadam road construction method with neat sketch.
2. What are the requirements of highway alignment? Explain how the information collected in the preceding stages of survey are utilized in the succeeding stages of survey for highway alignment.
3. Write the necessity for extra widening of road pavement at horizontal curves. Derive an expression for finding the extra widening required on horizontal curve.
4. Explain the factors affecting geometric design of road.
5. A two-lane highway with a ruling gradient of 6% has a compensated gradient of 4.5% at a horizontal curve section of length 60m. The curve section has a sight obstruction at 2m from the edge of the carriageway. Determine the possible speed on the curve section based on stopping criterion. Assume coefficient of longitudinal friction of 0.35.
6. Two approaching cars were caught on head-on-collision at a vertical summit curve connecting 4% ascending gradient with 3.5% descending gradient. The posted speed on this road is 70 Km/hr. The highway engineer checked the geometrics of the road and found that the highest point of the vertical curve lies at the distance of 120m from the beginning of the vertical curve. Check if the crash is due to fault in posted speed sign. Height of car driver's eye = 1.08m, reaction time = 2.5 sec, coefficient of longitudinal friction = 0.35. What should be the posted speed if there is fault in posted speed limit sign?
7. Discuss the importance of Highway Drainage. Explain control mechanism of subsoil water with neat sketch.
8. Discuss the design and construction problems that are associated with hill road. What are the merits and demerits of river route and ridge route?
9. List out the desirable properties of the road aggregates. Describe the test procedure for the determination of Los Angeles abrasion value of the road aggregates.
10. What are the tests conducted on bituminous binders? Explain the Marshall method of bituminous mix design procedure in detail.

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TRIBHUVAN UNIVERSITY  
 INSTITUTE OF ENGINEERING  
**Examination Control Division**  
 2078 Poush

Exam.	Back	
Level	BE	Full Marks : 80
Programme	BCE	Pass Marks : 32
Year / Part	III / II	Time : 3 hrs.

*Subject: - Transportation Engineering I (CE 653)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
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1. How roads are classified in Nepal as per NRS 2070? Differentiate between public and private transportation. [4+4]
2. Explain the sequential structure of route location process for a highway. Describe the first two stages of engineering survey for highway alignment. [4+4]
3. What are the reasons of providing extra widening of pavement at horizontal curve? Derive an expression for extra widening required on horizontal curve. [4+4]
4. There is a horizontal highway curve of radius 400 m and length 200 m on the highway. Compute the setback distance required from the center line of the pavement on the inner side of the curve so as to provide for
  - a) Stopping sight distance of 90 m.
  - b) Safe overtaking distance of 300 m.

The distance between center line of road and inner lane is 1.9 m. [4+4]
5. Discuss the objectives of providing transition curve. Describe the method to designing length of transition curve. [3+5]
6. An ascending gradient meets the descending gradient: the grades are 5% and 4% respectively. Locate the chainage at the beginning and end of vertical curve. Calculate the elevation of the road at a distance of every 300 m on either side of the point of vertical intersection (PVI). If the elevation and chainage of the PVI is 500.50 m and 50+050 km respectively. Assume  $R = 10000$  m. [8]
7. What are the requirements of highway drainage system? Explain the method of controlling subsoil water with neat sketch. [4+4]
8. Discuss the design and construction problems in hill roads. Write the basic considerations in locating river route. [4+4]
9. List out the desirable properties of subgrade soil. Describe the test procedure to determine Los Angeles abrasion value of aggregate and discuss its significance. [4+4]
10. What are the tests conducted on bituminous binders? Explain the Marshall method of bituminous mix design procedure. [3+5]

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Programme	BCE	Pass Marks	32
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 Attempt All questions.  
 The figures in the margin indicate Full Marks.  
 Assume suitable data if necessary.

- Why road transportation is more relevance in the context of Nepal? Classify the types of road on the basis of Nepal Road Standard? [4+4]
- What are the objectives of highway planning? Describe the sequential structure of route location process. [4+4]
- Discuss camber with its type. Derive an expression for superelevation with neat sketch. [4+4]
- A two-lane two-way highway has a curve 500m long and radius of 300m. The curve has an obstruction to sight of 10m from its inner edge. Determine the sight distance that can be provided on the curve section. Check if this sight distance meets the overtaking sight distance requirement for a speed of 50kmph. Assume the coefficient of longitudinal friction of 0.35 and overtaking acceleration of 3.6 km/hr/sec. [8]
- Briefly explain the types of sight distances. Derive the expression for overtaking sight distance for two lane two way roads with neat sketches. [4+4]
- A vertical curve connects a -3.5% grade with +4% grade on a highway at an elevation of 50.5 m. The curve should be designed at least to provide the visibility of the road surface at a distance of 250m at night time. Calculate the elevation of beginning, lowest and end point of vertical curve and at a distance of 75m left and 60m right from the point of vertical intersection. The head light beam angle and height of the head light from the road surface is 1.5° and 0.6m respectively. [8]
- Explain the types of cross drainage structures used in highway. [8]
- Discuss the factors controlling alignment of hill road. List out and illustrate the typical configurations of cross-sections for hill roads. [4+4]
- What are the various tests conducted in road construction for judging the suitability of road aggregates? Describe the test procedure to determine the Los Angeles Abrasion value. [4+4]
- Explain bituminous mixes types. Describe the softening point test on bituminous binders and its significance. [4+4]

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TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
Examination Control Division  
2077 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

*Subject: - Transportation Engineering I (CE 653)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
  - ✓ Attempt All questions.
  - ✓ The figures in the margin indicate Full Marks.
  - ✓ Assume suitable data if necessary.
1. What are the advantage of road transport over other modes of transportation. Discuss urban network planning in brief. [4+4]
  2. What are the requirements of an ideal highway alignment? Describe the procedure of the conventional method of preliminary survey. [4+4]
  3. Differentiate between camber and superelevation. Describe methods of providing superelevation. [3+5]
  4. Calculate the length of transition curve and shift, if the design speed is 60kmph. The radius of circular curve is 220m. An allowable rate of change of centrifugal acceleration is  $60\text{cm/sec}^3$ . Allowable rate of change of superelevation is 1 in 120. The width of the pavement is 7.00m. Assume rotation of Pavement about the inner edge. [8]
  5. Discuss the different types of gradients used in highway? What are the causes of proving grade compensation in highway? [5+3]
  6. A section of highway has vertical and horizontal curves with the same design speed. A horizontal curve on this highway with a ruling radius and a deviation angle of  $45^\circ$  is 180m long. Design the length of a vertical curve on this highway connecting a +3% grade with -1.5% grade so as to fulfill the stopping sight distance criteria. Assume coefficient of longitudinal friction as 0.35. [8]
  7. Define highway drainage system. List out its requirements. Explain with neat sketches a proper subsurface drainage system to lower the underground water table. [1+3+4]
  8. Define hill road. Describe the factors to be considered in hill road design. [8]
  9. What are the desirable properties of sub-grade soil? Describe the crushing strength test of road aggregate. [4+4]
  10. Write down the laboratory procedure of Marshall Stability test of bitumen mixes. [8]

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**Subject:** - Transportation Engineering I (CE653)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
  - ✓ Attempt All questions.
  - ✓ All questions carry equal marks.
  - ✓ Assume suitable data if necessary.
1. Differentiate between public and private transportation. Why macadam is considered as a pioneer of modern roads?
  2. What are the requirements of good Highway alignment? Explain different stages of surveying for highway alignment.
  3. Discuss the effects of a horizontal curve on which vehicle stability depends and derive the condition for overtaking and skidding.
  4. National highway curve of 400 m radius to be set out to connect two straights. The maximum speed of moving vehicles on this curve is restricted to 85 Kmph. Transition curve are to be introduced at each end curve. Calculate:
    - i) A suitable length of transition curve
    - ii) The necessary shift of circular curve
    - iii) The chainage at the beginning and end of curveGiven that angle of intersection- $125^{\circ}25'$   
Rate of change of centrifugal acceleration =  $0.52 \text{ m/sec}^3$   
Chainage at the point of intersection = 1075.5 m
  5. Explain the factors that govern the stopping sight distance. Derive the expression for analysis of stopping sight distance.
  6. A vertical curve is to be designed when as ascending grade of line 60 meets a descending grade of 1 in 45 on a highway. The stopping sight distance and overtaking sight distance required are 210 m and 600 m respectively. But due to site condition, the length of curve has to be restricted to a maximum value of 750 m if possible. Calculate the length of curve needed to fulfill the requirements of:
    - i) Stopping sight distance
    - ii) Overtaking sight distance
    - iii) At least intermediate sight distance and discuss the results
  7. What are the components of highway drainage system? Write down the design steps for surface drainage system.
  8. What are design and construction problems in hill roads? Describe the different methods that hill road alignment can be located.
  9. Enumerate the desirable properties of road aggregate. Briefly describe the laboratory test to determine impact value of aggregate.
  10. Define bitumen premixes. Explain the Marshal method of Bitumen mix design

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*Subject: - Transportation Engineering (CE653)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. Write down the scope of highway engineering. What are the characteristics of road transport in comparison with other modes of transportation?
2. Enlist the requirements of highway alignment. Write the process of detailed engineering survey of highway alignment.
3. Define stopping sight distance. Explain the factors affecting stopping sight distance. Derive the expression for stopping sight distance.
4. A horizontal curve of 625 m radius is to be set out to connect two straight of a national highway. The speed of the vehicle is restricted to 90 Kmph. Calculate
  - a) length of transition curve
  - b) the chainage of beginning and end of the curve given that,  
angle of intersection =  $130^{\circ}24'$   
rate of change of centrifugal acceleration =  $0.25 \text{ m/s}^3$
  - c) chainage of point of intersection = 1092.500m
5. Design the total length of the valley curve at the junction of the descending gradient of 1 in 40 and an ascending gradient of 1 in 30 if the design speed is 100 kmph. So as to fulfill both comfort condition and head light sight distance for night driving. Locate the lowest point and the end of curve point too. Calculate their elevations if the elevation of the beginning of the curve is 312.56m above sea level. Assume other necessary data reasonably.
6. Explain the different types of gradient and factors to be considered in its selection.
7. Explain how the surface water is collected and disposed-off in rural and urban roads. What are the special problems in drainage of surface water in hill roads?
8. Explain the special considerations and challenges of hill road construction?
9. Explain the desirable properties of sub-grade soil? Also explain the impact test of aggregate.
10. Define bitumen premixes. Explain the laboratory test procedure of Marshall stability along with its significance.



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- ✓ Candidates are required to give their answers in their own words as far as practicable.
  - ✓ Attempt All questions.
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  - ✓ Assume suitable data if necessary.
1. Explain the relevancy of road transportation in the context of Nepal.
  2. Explain the engineering surveys to be carried out for a highway alignment.
  3. What are the importance of highway geometric design? Critically discuss various factors that affect geometric design of road.
  4. Define super elevation. Explain the methods of introducing super elevation with neat sketches.
  5. Calculate the minimum sight distance required to avoid a head-on collision of vehicles approaching from the opposite directions speed at 60 kmph. Use the total perception reaction time of 2.5 seconds, coefficient of friction 0.40 and brake efficiency of 50%. The section of the road under consideration has a grade of 10%.
  6. A vertical curve connects a - 3.0% grade with + 4.5% grade on a rural highway at station 6+525 and elevation 411.6m. The curve should be designed at least to provide the visibility of the road surface to a distance of 250 m at night time. Locate the starting, lowest, and end point of vertical curve. Calculate the elevation of road at all these points along the curve and at a distance of 50m left and right from the point of vertical intersection. Assume the head light beam angle and heights of the head light from the road surface for the design vehicle are 2° and 0.6m respectively.
  7. Define cross-drainage structure. Explain its types with neat sketches.
  8. What are various problems in hill road construction? List out different characteristics for ridge route and river route location.
  9. Explain the desirable properties of aggregate to be used in different types of pavement construction.
  10. What are the different types of bitumen? Write down the laboratory procedure of ductility test of bitumen.

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Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering (CE653)**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
  - ✓ Attempt All questions.
  - ✓ All questions carry equal marks.
  - ✓ Assume suitable data if necessary.
1. Describe the different modes of transportation. Which mode of transportation is suitable for Nepal? Give reasons.
  2. What is highway alignment? Describe how the information collected in preceding stages is updated in successive stages in road alignment survey.
  3. Define extrawidening. What are the reasons of providing extrawidening on horizontal curve? Derive the expression for determining extrawidening.
  4. There is a horizontal curve with radius of 450m and length 220m on the six lane Koteshwor-Suryabinayak highway. Compute the setback distance required from the edge of the inner lane of the highway so as to provide (i) stopping sight distance of 100 m and (ii) safe overtaking sight distance of 310 m.
  5. What are the objectives of providing transition curve? Derive an expression for the length of transition curve in horizontal alignment.
  6. A vertical curve connects -3.25% grade with +3.75% grade. The curve should be designed at least to provide the visibility of the road surface to a distance of 225 m at night time. Calculate elevation of BVC, lowest point and EVC if the RL of the curve at 18m distance from EVC is 125.32 m.
  7. Clarify the necessity of the following elements of highway drainage:
    - i) Catch drain
    - ii) Causeway
    - iii) Energy dissipating structure
    - iv) Sub-surface drainage
  8. What are the design and construction problems that are associated with hill roads? Enumerate the merits and demerits of River Route and Ridge Route.
  9. What are the desirable properties of sub grade soil? Explain briefly the test procedure of LOS Angeles Abrasion test on aggregates.
  10. Enumerate the various types of consistency tests on bituminous binders. Explain the procedure and significance of Penetration test.

03 TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2073 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

*Subject: - Transportation Engineering (CE653)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
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1. Discuss the classification of roads as per Nepal road standard (NRS 2070). Why road transportation is considered the most feasible in Nepal? [8]
2. Describe the requirements and factors affecting the highway alignment. [8]
3. Discuss about PIEV theory with example. Define Stopping Sight distance and enumerate the various factors affecting the stopping sight distance. [3+5]
4. The angle of intersection between two straights is  $145.37^\circ$ . The spiral angle for each transition curve is  $10.32^\circ$ . Calculate the length of transition curve, combined length of curve and the length of tangent if the radius of the curve is 350 m. [8]
5. Define superelevation. Derive an expression for superelevation.
6. An ascending gradient of 2.75% meets with descending gradient of 2.25%. The radius of curve is 5000 m. If the reduced level of the curve at a distance of 60 m from BVC is 312.12 m, find the reduced level of BVC, EVC and highest point of the curve. [8]
7. Describe the causes of moisture variation in subsurface soil. Explain with neat sketches how the sub surface drainage is provided to lower the water table and control of seepage flow. [1+3+4]
8. Explain briefly the special consideration to be taken in hill road design. Draw neat sketches of different types of cross section of hill road. [8]
9. What are the desirable properties of road aggregates? Explain the crushing value test of aggregate? [4+4]
10. Describe the procedure of Marshall Stability test in laboratory. [8]

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03      TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

*Subject: - Transportation Engineering (CE653)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
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1. Explain the components of transportation system. What are the objectives of road planning?
2. Mention engineering surveys to be carried out for highway location. Explain Preliminary Survey for Highway location in brief.
3. Derive an expression for finding the superelevation required if the design coefficient of friction is 'f'. List the design steps of superelevation.
4. A vertical summit curve is to be designed when two grades +1/60 and -1/45 meet on a highway. The stopping sight distance and overtaking sight distance required are 210 m and 600 m respectively. But due to site condition, the length of vertical curve has to be restricted to a maximum value of 750m if possible. Calculate the length of summit curve needed to fulfill the requirements of:
  - i) Stopping sight distance
  - ii) Overtaking sight distance or at least intermediate sight distance. Discuss the result
5. Define transition curve and its necessity in horizontal alignment. Describe the different methods of designing the length of transition curve.
6. A six lane highway has a curve 350 m long and 550 m radius. The stopping sight distance and overtaking sight distance are 200 m and 400 m respectively. Find out the setback distance from the inner edge of the road to the obstruction for both cases.
7. Define highway drainage system. Describe the causes of moisture variation in subsurface soil. Explain with neat sketches how the subsurface drainage is provided to lower the water table and control of seepage flow.
8. What are the design and construction problems that are associated with hill roads? Enumerate the merits and demerits of River Route and Ridge Route.
9. What are the different types of bituminous materials used in road construction? Explain briefly the test procedure of Los Angeles abrasion value of aggregate.
10. What are the desirable properties of bituminous mixes? Briefly explain the ductility test of bitumen and its engineering application.

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1. ✓ What are the objectives of road planning? Explain the major road patterns developed in modern urban areas.
  2. ✓ Explain the factors that affect the selection of highway alignment.
  3. ✓ Derive an expression for finding the superelevation required if the design coefficient of friction is 'f'. Describe briefly the various methods of providing superelevation with sketches.
  4. ✓ What are the curve resistance and grade compensation? Describe the disadvantages of heavy camber.
  5. ✓ A vehicle moving in a horizontal curve at a design speed of 65 kmph, develops a centrifugal ratio of 1/5. The deflection angle at curve is 48°. Calculate:
    - a) radius of circular curve
    - b) length of transition curve by rate of change of centrifugal acceleration criteria
    - c) total length of composite curve
  6. ✓ The driver of a vehicle travelling at 65 kmph down a grade required 12m more stopping sight distance to stop than the driver travelling at same speed up the same grade. If the coefficient of friction between tire and pavement is 0.38. Determine the percent grade and stopping sight distance up the grade.
  7. ✓ Classify highway drainage. What are the requirements of highway drainage?
  8. ✓ Describe different types of retaining walls used in road construction. List out the basis of its selection.
  9. ✓ Explain the materials used in different layers of the road pavement. Describe the desirable properties of road aggregates for pavement works.
  10. ✓ What are the tests to be conducted on road binders for its suitability on road construction? Describe the test procedure to determine the softening point of bitumen.

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1. Explain briefly, the classification of transportation system. [8]
2. What are the requirements of highway alignment? Explain the importance of map study in highway survey. [8]
3. What are the functions of transition curve? Derive an expression for the length of transition curve to be introduced between the straight and circular path on a horizontal curve from two criteria. [8]
4. Describe the factors which control the geometric elements of road and discuss the reasons for providing an additional width of carriageway on horizontal curve. [8]
5. A four lane carriageway has a curve of 220 m length and 400 m radius. The safe stopping sight distance and overtaking sight distance are 152 m and 300 m respectively. Calculate the minimum set-back distance from the inner edge of the road to the edge of the obstruction to ensure safe visibility for the both cases of sight distances if the width of the pavement per lane is 3.75 m. [8]
6. Design the length of valley curve with a descending grade of 1/35 and ascending grade of 1/45. The design speed is 80 kmph. Determine the RL of beginning, lowest and end point of curve if the RL of PVI is 212.36 m so as to fulfill both comfort condition and head light sight distance for night visibility. Also determine the apex distance and mid ordinate of the curve. Assume coefficient of friction = 0.35, Rate of change of centrifugal acceleration = 60 cm/sec<sup>3</sup>. [8]
7. Why drainage is an important part of highway design? What are the causes of moisture variation in sub-grade soil? [8]
8. Sketch different types of hill road cross-sections. Discuss hill road drainage structures. [8]
9. Define bitumen premixes. Explain the Marshall design method for the Asphalt concrete. [8]
10. Explain briefly the desirable properties of sub-grade soil. Explain the test procedure of the penetration value of bitumen. [8]

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1. Explain briefly, the classification of transportation system. [8]
2. What are the requirements of highway alignment? Explain the importance of map study in highway survey. [8]
3. What are the functions of transition curve? Derive an expression for the length of transition curve to be introduced between the straight and circular path on a horizontal curve from two criteria. [8]
4. Describe the factors which control the geometric elements of road and discuss the reasons for providing an additional width of carriageway on horizontal curve. [8]
5. A four lane carriageway has a curve of 220 m length and 400 m radius. The safe stopping sight distance and overtaking sight distance are 152 m and 300 m respectively. Calculate the minimum set-back distance from the inner edge of the road to the edge of the obstruction to ensure safe visibility for the both cases of sight distances if the width of the pavement per lane is 3.75 m. [8]
6. Design the length of valley curve with a descending grade of 1/35 and ascending grade of 1/45. The design speed is 80 kmph. Determine the RL of beginning, lowest and end point of curve if the RL of PVI is 212.36 m so as to fulfill both comfort condition and head light sight distance for night visibility. Also determine the apex distance and mid ordinate of the curve. Assume coefficient of friction = 0.35, Rate of change of centrifugal acceleration = 60 cm/sec<sup>3</sup>. [8]
7. Why drainage is an important part of highway design? What are the causes of moisture variation in sub-grade soil? [8]
8. Sketch different types of hill road cross-sections. Discuss hill road drainage structures. [8]
9. Define bitumen premixes. Explain the Marshall design method for the Asphalt concrete. [8]
10. Explain briefly the desirable properties of sub-grade soil. Explain the test procedure of the penetration value of bitumen. [8]

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Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering- I (CE653)**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
- ✓ **All** questions carry equal marks.
- ✓ Assume suitable data if necessary.

- 1 Explain the road classification system based on Nepal Road Standard. Why road transportation is considered the most feasible in our country?
- 2 What are the requirements of an ideal highway alignment? Describe the information needed to be collected during reconnaissance survey.
- 3 Discuss the design controls for the geometrics of road and governing factors which affect the stopping sight distance.
- 4 Define super elevation, and derive the expression for super elevation. List the design steps of super elevation.
- 5 The angle of intersection between two straights is  $137.23^\circ$ . The spiral angle for each transition curve is  $8.35^\circ$ . Calculate the length of transition curve, combined length of curves and length of tangent if the radius of the curve is 325 m.
- 6 An ascending gradient of 3.75% meets with descending gradient of 3.25%. Calculate the chainage and elevation of beginning of the curve, end of the curve, highest point of the curve and 90 m left from the point of vertical intersection if the chainage and elevation of PVI are 1+ 225.00 and 875.62 m respectively. The radius of curve provided is 8000 m.
- 7 What are the causes of moisture variation in sub-grade soil? What are the factors to be considered in designing sub-surface drainage system to check seepage flow?
- 8 Discuss the road side structures to be provided for the road way stability. Explain how you will stabilize landslides along the road.
- 9 Define bitumen premixes. Explain the Marshall design procedure for the bituminous premixes.
- 10 What are the desirable properties of sub-grade soil? Explain the method of Los Angeles abrasion test on aggregate.

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Exam.	Regular / Back		
	Level	BE	Full Marks
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject:** - Transportation Engineering I

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any **Five** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.

1. a) What is transportation planning? Why the development of public transportation should be given preference over the development of private transportation? [8]  
b) What are the different stages of surveying for highway alignment? List out the various components of economical appraisal. [8]
2. a) Classify the highway curves. What type of effects will take place when the vehicle negotiates a horizontal curve without super elevation? Also give reasons. [8]  
b) Calculate the length of transition curve using the following data: [8]
  - i) Design speed = 65 kmph
  - ii) Radius of circular curve = 220m
  - iii) Allowable rate of introduction of super elevation (Pavement rotated about centre line) = 1 in 150
  - iv) Pavement width including extra widening = 7.5m
3. a) Explain PIEV theory. Derive an expression for determining the stopping sight distance at level ground. [8]  
b) A summit curve is to be provided at the intersection of two gradients +1.5% and -2%. What is length required (i) For stopping sight distance of 200m (ii) For overtaking sight distance of 600m? What is the vertical distance between the point of vertical intersection and curve in either case? [8]
4. a) Describe the different types of retaining walls used in road construction. Mention the basis of its selection. [8]  
b) What do you mean by penetration value of bitumen? Describe step by step procedure for the determination of penetration value of bitumen in the laboratory. [8]
5. a) Explain the different types of erosion control and energy dissipating measures used in highway drainage system. [8]  
b) Explain different measures that are taken to stabilize the formation and cross slopes in hill road construction. [8]
6. Write short notes on: [4×4]
  - a) Requirements of highway alignment
  - b) Extra widening
  - c) Road classification system
  - d) River route

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any **Five** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.

1. a) What is transportation planning? Explain philosophical elements of a long term transport planning. [8]
- b) Mention the stages of highway survey. Describe the information to be collected during reconnaissance survey. [8]
2. a) What is an overtaking sight distance? Derive an expression for overtaking sight distance with neat sketch. [2+6]
- b) Calculate the length of a transition curve required for a road with carriageway width of 7.0m on a straight portion, if the design speed is 65kmph. Assume that the road is passing through a rolling terrain. The radius of the horizontal curve is 200m and pavement is rotated about the centre line. Assume suitable data if necessary. [8]
3. a) Define PIEV theory. Derive an expression to determine the extra widening. [2+6]
- b) A valley curve divided by a descending gradient of 1 in 30 meeting an ascending gradient of 1 in 25. Design the length of valley curve to fulfill both comfort condition and head light sight distance required for a design speed of 80Kmph. Assume allowable rate of change of centrifugal acceleration is  $0.6\text{m/sec}^2$  and stopping sight distance is 160m. [8]
4. a) What is penetration value of bitumen? Describe the procedure for the determination of penetration value in laboratory. [2+6]
- b) What are the causes of soil erosion? Describe preventive measures of soil erosion and energy dissipation. [8]
5. a) Classify the cross drainage structures as per NRS. Describe the suitability of construction of pipe, box, slab and arch culverts. [8]
- b) List various test carried out on road aggregates. Explain the procedure for determination of Los Angeles abrasion test. [8]
6. Write short note on: (any four) [4×4]
  - a) Bitumen emulsion
  - b) Un-submerged and submerged conditions for minor bridge
  - c) Retaining structures
  - d) Hill road drainage
  - e) Curve resistance and grade compensation

Exam. Level	Regular/Back		
	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Why is Macadam Road superior to Telford Construction? Make sketches of those road sections. Write down the scope of Highway Engineering. [8]
- b) What are the types of road patterns in urban areas? Explain them briefly with the help of neat sketches. [8]
2. a) List out important factors which control the geometric elements of roads. Calculate safe stopping sight distance for the design speed of 50 kmph for: (i) two-way traffic on a two lane road (ii) two-way traffic on a single lane road. Assume appropriate data for calculation. [2+3+3]
- b) Derive the expression for the length of transition curve to be introduced between the straight and the circular path on a horizontal alignment from two criteria. [8]
3. a) What are the basic design controls for valley curves? How the length of valley curve is calculated from different criteria? [8]
- b) Define PIEV theory. A National Highway passing through a rolling terrain has a horizontal curve of radius of 200m. Find out the length of a transition curve assuming suitable data. [2+6]
4. a) Briefly describe the special structures constructed in hill roads. Make the sketch of drainage system layout in hill roads. [8]
- b) Write down the steps for the design of longitudinal drains of a road to drain off the surface water. Classify cross drainage structures as per NRS. [8]
5. a) Explain with neat sketches the phenomenon of lowering of the water table, control of capillary and vapour rise to strengthen the sub-grade of a road embankment. [8]
- b) Write down the tests carried out on road aggregates and describe their significance. [8]
6. Write short notes on: (any four) [4×4]
  - a) Penetration test on bitumen
  - b) River crossing alternatives
  - c) Super elevation in hill roads
  - d) Resistance to vehicular motion
  - e) Selection of an ideal alignment

Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any **Five** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.

1. a) Derive the expression for the length of transition curve from two considerations. [8]  
 b) Due to drainage problem, the inner edge cannot be lowered and a super elevation of  $e$  is to be introduced. Explain, how the two way slope of  $n$  can be gradually converted to a one way slope of  $e$  where  $e > n$  with a neat sketch. Given the road width is  $W_m$  and the transition curve length is  $L$  m. [8]
2. a) A 30<sup>th</sup> hourly volume is generally accepted as the design volume of traffic, why? What are the other design controls for the geometrics of road? Discuss in brief. [8]  
 b) At a deviation point with deviation angle equal to  $10^\circ 50'$  and radius of horizontal circular curve of 400m, a symmetrical spiral-circular curve with 120m long spiral could not be introduced. Prove it. Give suggestions for other possible solutions. [8]
3. a) Derive an expression for minimum permissible radius of valley curve from two considerations. [10]  
 b) Outline the various reasons requiring grade compensation. [6]
4. a) A 300m line ascending section of a double lane road with two way traffic road with 4% grade meets with a 300m long descending section with 3% grade. Design the vertical curve to meet the visibility requirement. Design speed is 100 kmph. The braking efficiency is 90%. Calculate the formation levels of main points on curve at a distance of 50m from PVI on either sides, at the highest point of the formation lines and at the beginning and end section of road, given the final formation level of the road at a distance of 25m right from PVI as 120.105. [8]  
 b) Enumerate the various types of consistency tests on bituminous binders. Why do we need different types of consistency tests? How is the ductility test carried out? What is the significance of this test? [8]
5. a) The table below gives the sieve analysis results of three gravel quarries under investigation. Calculate the mixing properties; to meet the given gradation specification. [10]

Sieve size mm	Percentage passing given sieve size			Specification
	Quarry A	Quarry B	Quarry C	
25.4	100	100	100	100
12.7	100	100	95	90-100
4.76	100	100	55	60-75
1.18	100	65	30	40-55
0.30	100	25	23	20-35
0.15	75	18	9	12-22
0.075	40	5	3	5-10

- b) Draw neat sketches and describe different types of hill roads cross section. [6]
6. Write short notes on: [4x4]
  - a) Air resistance
  - b) Hairpin bend
  - c) Historical development of road
  - d) Control of seepage flow

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Compare the main features of Telford and Macadam construction. Why Macadam is known as the pioneer of modern roads? [6+2]
- b) Name the various steps to be followed for a highway alignment location. Describe the works to be carried out and data to be collected during final location survey. [2+6]
2. a) What is lining o drains and when is it necessary? What are the causes of moisture variation in subgrade soil? How do you control excess moisture in subgrade soil due to subsurface sources of water? [2+2+4]
- b) Explain in brief about petroleum bitumen, cutback bitumen, and bitumen emulsion. How do you perform softening point test of bitumen and what is the use of this test? [4+3+1]
3. a) The centre line of a two lane road has an elevation of 320.00m. The camber of the pavement is 3.0% and cross-slope of shoulder is 5%. Calculate the elevation of pavement at centre of lane, edges of pavement and at road edge if [8]
  - i) Straight line camber is to be provided.
  - ii) Parabolic camber is to be provided.

Take with of lane 3.5m and shoulder width as 1.5m.
- b) Define extra widening and its causes of providing and derive an expression of extra widening. [1+2+5]
4. a) What do you mean by tractive resistance, explain it is brief? [2+6]
- b) Calculate the minimum setback from centre line of road for a curve of radius 500m for a six lane road to ensure safe visibility. The stopping right distance is 200m, lane width is 3.5m and the curve length is 100m and not extra width is to be provided. [8]
5. a) Explain stopping sight distance and derive its expression. [2+6]
- b) A two lane pavement 7m in width in hilly region has a curve of radius 60m, the design speed is 40 kmph. Determine the length of transition curve, total curve length and total tangent length if the deflection angle of the curve is 60°. Take superelvation = 0.07, extra width = 1.2m, 1:N = 1:60. Assume that the rotation of pavement is about centre line. [4+2+2]
6. Write short notes on any four: [4×4]
  - a) Los Angeles Abrasion Test
  - b) Retaining Wall
  - c) Breast Wall
  - d) Slab culvert and its elements
  - e) Typical cross-section of hill roads
  - f) Modes of transportation

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Briefly, describe the historical development of roads and road construction in Nepal. What is the current state of affair in road construction situation in Nepal? What are government's plans regarding this issue? [4+2+2]
- b) Define and describe the terms region, band, corridor and alignment with respect to the map study for highway route identification. [2+2+2+2]
2. a) Due to drainage problem, the inner edge cannot be lowered and a super elevation of 'e' is to be introduced. Explain with the help of a neat sketch, how do you obtain one way slope, e, from two way slope, n, where  $e > n$ . Given the road width is W m and the transition curve length is L m. [8]
- b) The centre line of a double lane road has an elevation of 320.50m as recorded from longitudinal profile. The camber is 2.5% and cross fall of shoulder is 5%. Calculate the elevation of road surface at the centre of lane, edges of pavement and road edges if (i) straight line camber is provided (ii) parabolic camber is provided. Take the shoulder width 1.5m and lane width 3.5m. [8]
3. a) Define extra widening. State the objectives of pavement widening on horizontal curves. Write down the formulate for total extra widening. What are the methods of providing extra widening on horizontal curves? [1+2+2+3]
- b) A transition curve needed to connect a circular section with a straight section of a highway. If the design speed of highway is 90 kmph and radius of the circular section is 300m. Determine the length of transition curve for comfort and for introducing super elevation at your suitably selected desirable rate. The width of pavement at straight section is 7m and length of the wheel base of the design vehicle is 6.1m. [8]
4. a) Define highway drainage. What are the requirements of a good highway drainage system? Explain how the surface water is collected and disposed off in rural, urban and hill roads. [1+3+4]
- b) Determine the actual grade along the centre line of the inner most and outer most lanes of the road with 15m wide carriage way long the circular curve of radius 75m if the grade along the centre line of the road is 5%. Do not consider the extra widening. The deflection angle at that point is  $45^\circ$ . [8]
5. a) What are the design and construction problems of hill road? How do the temperature, rainfall, pressure and geology of the region affect the selection of hill road alignment? [4+4]
- b) Describe in brief road rapids, drop structures, causeways and inverted siphons. Give sketches where ever possible. [2+2+2+2]
6. a) Distinguish between Aggregate Impact Value, Aggregate Abrasion Value and Aggregate Crushing Value. Why is it necessary to determine flakiness and elongation indices of an aggregate sample? [6+2]
- b) What do you mean by bituminous mixes? Describe in brief Marshall Stability Test for determining optimum binder content in bituminous mixes. [2+6]

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

*Subject: - Transportation Engineering I*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any Five questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. a) Describe different modes of transportation. Explain briefly the advantage and disadvantage of road transportation. [8]  
b) Define highway alignment. Explain the factors controlling highway alignment. [8]
2. a) What is overtaking sight distance? Derive an expression for overtaking sight distance with neat sketch. [8]  
b) A descending section of a road with 3% grade meets an ascending section with 4% grade. Design the vertical curve. The stopping sight distance requirement is 120m. Calculate the formation levels of main points on curve and at a distance of 30m both sides from the point of vertical intersection (PVI). The reduce level of PVI is 243.154m. Assume other data suitably. [8]
3. a) Derive an expression for finding minimum radius of valley curve with night visibility. [6]  
b) At a certain section of road there is an intersection point (IP) with an angle of  $45^{\circ}30'$  turning right. The minimum permissible radius is 200m. The distance between starting point and IP and IP to end point are 500 and 350m respectively. Calculate the elements of circular curve and chainages of main points of curve assuming the chainage of starting point is to be 20 + 416.60. [8]
4. a) Explain with neat sketches different typical types of cross sections in hill road. [8]  
b) Explain briefly about the route location in hill road design. [8]
5. a) Discuss the causes of moisture variation in sub-grade soil. Why drainage structures are important in road construction. [8]  
b) Explain with sketches how the surface water is collected and disposed off in the hill roads. [8]
6. a) Describe Marshal method of bituminous mix design procedure. [8]  
b) Enlist the various tests on road aggregates. Explain briefly the test procedure of crushing value of the aggregate. [8]

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Exam. Level	Regular/Back		
	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any **Five** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.
1. a) Discuss in detail the classification of roads as per Nepal Road Standard (NRS) on the basis of traffic flow and service flow. [4+4]
  - b) Discuss the different pattern of Urban Network Planning with neat sketches. Explain briefly, the use of ring road helps to address the problem of city core congestion with neat sketches. [4+4]
  2. a) Define stopping distance. Enumerate the various factors affecting stopping distance. Explain the relationship between the stopping distance and stopping sight distance. [1+4+3]
  - b) The centre line of a double lane road has an elevation of 315.5m as recorded from longitudinal profile. The camber is 3.0% and the lane width is 3.5m. Find the elevation of the road at the edges of the pavement and the center of lane if (i) straight line camber is provided, (ii) parabolic camber is provided. [8]
  3. a) Define transition curve. Mention the need of introducing transition curve in horizontal alignment. Derive the different methods of designing the length of transition curve. [1+2+5]
  - b) How much should be the outer edges of the pavement to be raised with respect to the centre line on a two lane road designed for mix traffic at a speed of 80 km/hr on a horizontal curve of radius 200m if the super elevation is obtained by rotating the pavement with respect to the (i) centre line, and (ii) inner edge. [8]
  4. a) Why do we need to compensate grade in horizontal curves? Give three reasons. [4]
  - b) Design the total length of valley curve at the junction of a descending gradient 2.5% and the ascending gradient of 3.5% if the design speed is 80 kmph, so as to fulfill both comfort condition and head light sight distance for night driving. Locate the lowest point and determine its elevation if the elevation of beginning of the curve is 415.5m. Assume other suitable data if necessary. [12]
  5. a) Define highway drainage system. Describe the causes of moisture variation in subsurface soil. Explain with neat sketches how the surface drainage is provided to lower the water table, and control of seepage flow. [1+3+4]
  - b) What are the design and construction problems that are associated with hill roads? Enumerate the merits and demerits of river route and ridge route. [4+4]
  6. a) What do you mean by crushing value of aggregates? Describe the step by step procedure for determining crushing value of aggregates? Suggest the ranges of crushing value for aggregates in lower and in surface layers of the road pavement structures. [1+5+2]
  - b) Explain in brief about natural bitumen, cutback bitumen, bitumen emulsion and tar with their importance. [2+2+2+2]
  7. Write short notes on (any four): [4×4]
    - a) Telford Construction
    - b) Culverts
    - c) Hair Pin Bend
    - d) Aqueducts and Inverted Syphon
    - e) Factors Controlling Highway Alignment



Exam. Level	B.E.	Back	
		Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

**Subject: - Transportation Engineering I**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt any **Five** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.

1. a) Explain briefly the various forms of urban road network system. How it is possible by the provision of Ring Road to minimize the congestion in the city core areas. [8]
  - b) What are the factors that controls the selection of highway alignment? Explain. [8]
2. a) What do you mean by super-elevation? Explain briefly in what conditions this super-elevation can be provided. [6]
  - b) The radius of horizontal circular curve is 100m. The design speed is 60 kmph. The coefficient of lateral friction is 0.17. [10]
    - i) Calculate the super elevation if full lateral friction is called into play.
    - ii) Calculate the coefficient of friction needed if no super elevation is provided.
3. a) Explain briefly the overtaking sight distance and the stopping sight distance. [6]
  - b) The speeds of overtaking and overtaken vehicles are 60 kmph and 30 kmph respectively on a two-way traffic road. If the acceleration of the overtaking vehicle is 3.6 kmph per second. [10]
    - i) Calculate the safe overtaking sight distance.
    - ii) Determine the minimum length of the overtaking zone.
4. a) What are the application of tangents, circular curves and transition curves in a horizontal alignment of a road. [8]
  - b) Calculate the length of the transition curve and the required shift, if the design speed is 60 kmph, the radius of the circular curve is 220m. And allowable rate of change of centrifugal acceleration is  $60 \text{ cm/sec}^3$ . Allowable rate of change of super elevation is 1 in 120. The pavement width including extra widening is 7.2m. [8]
5. a) What are the general tests in order to quality the aggregate in highway construction? Explain briefly. [6]
  - b) Bitumen is a very important material for road construction. Explain what tests you will perform in order to judge the quality of the bitumen before using it in road construction. [10]
6. a) Describe the various types of retaining structures helped by neat sketches. [8]
  - b) What is the function of energy dissipating structures in a highway drainage system? [8]
7. Write short notes on: (any four) [4×4]
  - a) Classification of roads in Nepal
  - b) Tar and Bitumen emulsion
  - c) Retaining wall and Breast wall
  - d) Surface and sub-surface Drainage System
  - e) Los Angels Abrasion Test
  - f) Aquaducts and Inverted Siphon
  - g) Hair Pin Bends