Transportation Engineering I
EG 3104 CE

Year: III **Total: 5 Hrs. /week**
Semester: I **Lecture: 3 Hrs./week**
Tutorial: 1 Hr./week
Practical: Hrs./week
Lab: 2/2 Hrs./week

Course Description:
This course is aimed to provide general background knowledge of highway engineering putting emphasis on alignment survey, geometric design, drainage, highway materials.

Course Objectives:
After the completion of this course, students will be able to:
1. Describe highway alignments and conduct its engineering survey;
2. Understand the principles of geometric design, both vertical and horizontal together with drainage components of highway;
3. Differentiate between the various types of materials used in road construction and
4. Perform different test of road construction materials.

Course Contents:

Unit 1: Introduction to Transportation System: [6 Hrs.]
- 1.1. Introduction
- 1.2. Comparison of different modes of transportation system, suitability in Nepal
- 1.3. Road transport and its advantages/disadvantages
- 1.4. History of road development
  - 1.4.1 Roman roads construction technique
  - 1.4.2 Tresaguet road construction technique
  - 1.4.3 Telford road construction technique
  - 1.4.4 Macadam road construction technique
  - 1.4.5 Comparison between Telford and Macadam
  - 1.4.6 Modern road construction
- 1.5. Road construction in Nepal
- 1.6. Road classification as per Nepal Road Standard (functional classification only), National, Feeder, District, Urban and Village road.
- 1.7. Urban road patterns
  - 1.7.1 Grid iron pattern
  - 1.7.2 Radial pattern

Unit 2: Highway Alignment and Engineering Survey: [4 Hrs.]
- 2.1. Introduction
- 2.2. Requirements of ideal highway alignment
- 2.3. Factors controlling highway alignment
- 2.4. Engineering survey for highway alignment
  - 2.4.1. Map study
  - 2.4.2. Reconnaissance,
  - 2.4.3. Preliminary survey
  - 2.4.4. Final location and detailed survey

Unit 3: Geometric Design of Highways: **[20 Hrs.]**

- 3.1. Introduction
- 3.2. Basic road terms
  - 3.2.1. Traffic volume (introduction only)
  - 3.2.2. Traffic capacity (introduction only)
  - 3.2.3. Skid/slip (introduction only)
- 3.3. Cross sectional elements
  - 3.3.1. Typical drawings of highway cross sections, rural roads/ urban roads
- 3.4. Camber
  - 3.4.1. Definition
  - 3.4.2. Objectives
  - 3.4.3. Types
  - 3.4.4. camber board preparation with numerical example
- 3.5. Highway curves
  - 3.5.1. Introduction, Types (Horizontal & Vertical)
  - 3.5.2. Necessity
  - 3.5.3. Design of horizontal curves (Effect of centrifugal force, transition curve with numerical examples)
- 3.6. Superelevation
  - 3.6.1. Definition
  - 3.6.2. Objectives
  - 3.6.3. Analysis of superelevation with numerical example of superelevation design in mixed traffic condition
  - 3.6.4. Methods of providing superelevation
- 3.7. Extrawidening
  - 3.7.1. Definition
  - 3.7.2. Objectives
  - 3.7.3. Analysis of mechanical widening with numerical example for calculating total widening
  - 3.7.4. Methods of providing extrawidening
- 3.8. Sight distance
  - 3.8.1. Definition
  - 3.8.2. Types
  - 3.8.3. Objectives
  - 3.8.4. Examples of situations restricting sight distance
  - 3.8.5. Numerical example of SSD & OSD
- 3.9. Gradient
  - 3.9.1. Definition
  - 3.9.2. Types (Rolling, Limiting, Exceptional, Minimum gradient)
  - 3.9.3. Factors governing the selection of grades, effect of high grades
  - 3.9.4. Grade compensation in horizontal curves (introduction only)
- 3.10. Vertical curves
  - 3.10.1. Definition
  - 3.10.2. Types (Summit & Valley)
  - 3.10.3. Design of summit curves (minimum length requirement based on stopping sight distance with numerical example)
  - 3.10.4. Design of valley curves (minimum length requirement based on both comfort and head light sight distance with numerical example)

Unit 4: Highway Drainage: **[5 Hrs.]**

4.1. Introduction and important of highway drainage
4.2. Causes of moisture variation in subgrade soil (By ground water & By free water concept only)
4.3. Requirements of good drainage system
4.4. Classification of highway drainage system
    4.4.1. Surface drainage (Types, longitudinal: lined and unlined, transverse, energy dissipating definitions), Drainage in rural highway, urban street, hill road concept, Design of surface drainage system (Numerical trapezoidal section)
    4.4.2. Subsurface drainage (Control of seepage flow, capillary rise, lowering of water table)
    4.4.3. Cross drainage (General, concept of causeways, inverted syphon, aqueduct, culverts: slab, box, arch & pipe)
    4.4.4. Energy dissipating structures: concept only.

Unit 5: Highway Materials: **[10 Hrs.]**

5.1. Classification of highway materials: Introduction, Classification based on purpose binding, mineral, other minerals.
5.2. Subgrade soil
    5.2.1. Uses
    5.2.2. Requirements of soil as a highway material
    5.2.3. California Bearing Ratio (CBR) test of soil (Test procedure)
5.3. Stone aggregates
    5.3.1. Definition
    5.3.2. Types: based on strength, grain size, shape, gradation basic concept only.
    5.3.3. Desirable properties of road aggregates
    5.3.4. Tests on road aggregates (Los Angeles Abrasion test, Aggregate Impact test, Water absorption test, Specific Gravity test, Shape test)
5.4. Binding materials (bituminous material):
    5.4.1. Introduction
    5.4.2. Types of binding materials (bitumen, tar), natural bitumen, petroleum bitumen, cutback bitumen, bituminous emulsion
5.5. Tests on bitumen: penetration test, ductility test, viscosity test, softening point test

Tutorials **[15 Hrs.]**

Unit 3 Geometric Design of Highways [12 H]
Unit 4 Highway Drainage: [3H]

Practical (laboratory) **[15 Hrs.]**

1. Perform California bearing test of soil
2. Perform Los Angeles Abrasion test of aggregate
3. Perform penetration test of bitumen
4. Perform softening point test of bitumen
5. Perform ductility test of bitumen

References:

1. Dinesh Kumar Shrestha, Anil Marsani, Transportation Engineering volume 1, Jasni Publications, Mid Baneshwor, Kathmandu, Nepal.

2. Partha Mani Parajuli, Course Manual on Transportation Engineering I. IoE, Pulchowk, Lalitpur, Nepal.
3. C E G Justo, S K Khanna, Highway Engineering, Khanna Publications, New Delhi, India
4. Ajay K Duggal, Vijaya P. Puri, Laboratory manual on Highway Engineering, New Age International (P) Limited, New Delhi, India.
5. S. K. Sharma, Principles, Practice and Design of Highway Engineering, S Chand and Company Ltd. New Delhi.

Evaluation Scheme

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Title	Hrs. (L+T)	Marks distribution
1	Introduction to Transportation System	6	12
2	Highway Alignment and Engineering Survey	4	16
3	Geometric Design of Highways	20+12	36
4	Highway Drainage	5+3	16
5	Highway Materials	10	16
	Total	**60**	**96**

Note:

Attempt any five questions out of six. All questions have (a) and (b) sub- questions.