**TRANSPORTATION ENGINEERING & PLANNING I: TCW 3105**

**Supplementary Examination Paper: Marking Scheme/ Marking Guide**

**August 2017**

**QUESTION 1**

1. List the major disciplines of transportation engineering and briefly discuss each one of the disciplines.

**Award 1 mark for each correct discipline listed (Geometric Design, Traffic Engineering, Transportation Planning and Pavement Design), 2mark for each correct brief discussion given.**

**Brief discussions for each discipline are a below:**

**Transportation planning**

Transportation planning essentially involves the development of a transport model which will accurately represent both the current as well as future transportation system.

This field focuses on the implementation of tools that aid in decision making with respect to transportation related projects.

**Geometric design**

Geometric design deals with physical proportioning of other transportation facilities, in contrast with the structural design of the facilities. The topics include the cross-sectional features, horizontal alignment, vertical alignment and intersections. Although there are several modes of travel like road, rail, air, etc. the underlying principles are common to a great extent. Therefore, emphasis will be normally given for the geometric design of roads.

**Pavement analysis and design**

Pavement design deals with the structural design of roads, both (bituminous and concrete), commonly known as (flexible pavements and rigid pavements) respectively. It deals with the design of paving materials, determination of the layer thickness, and construction and maintenance procedures. The design mainly covers structural aspects, functional aspects, drainage. Structural design ensures the pavement has enough strength to withstand the impact of loads, functional design emphasizes on the riding quality, and the drainage design protects the pavement from damage due to water infiltration.

**Traffic engineering**

Traffic engineering covers a broad range of engineering applications with a focus on the safety of the public, the efficient use of transportation resources, and the mobility of people and goods. Traffic engineering involves a variety of engineering and management skills, including design, operation, and system optimization. In order to address the above requirement, the traffic engineer must first understand the traffic flow behaviour and characteristics by extensive collection of traffic flow data and analysis. Based on this analysis, traffic flow is controlled so that the transport infrastructure is used optimally as well as with good service quality to all traffic infrastructure users. In short, the role of traffic engineering is to protect the environment while providing mobility, to preserve scarce resources while assuring economic activity, and to assure safety and security to people and vehicles, through both acceptable practices and high- tech communications.

**[12marks]**

1. Name the four major roles of transportation and discuss the importance of each.

**Award 1mark for each major role named (economic role, social role, political role and environmental role), 2mark for each correct brief discussion of the importance of transportation.**

1. **Economic role**: Transportation plays an important role in developing the economic aspect of a society. Economics involves production, distribution, and consumption of goods and services which are inevitable without the transportation facility. In a country which has a wide gap between production and consumption, an effective mode of transportation can always be helpful for its economic growth.
2. **Social role**: Development of transportation system influences the formation of urban society. It links rural areas with urban ones transporting goods from one place to other, eventually helping in overall development.
3. **Political role**: The world being divided into different political units is linked by transportation of both people and goods through different modes. Transportation plays a vital role in functioning of these political units.
4. **Environmental role**: the environment is highly affected by transportation. It's harmful aspect is more prominent than its useful aspects. Air pollution, noise pollution, overuse of non-renewable energy etc. are some of its impacts on the environment.

**[12marks]**

1. Define the following terms in relation to transportation engineering.

Award 1 mark for each correct definition and 1 mark for the sketch for c) iv

1. Average daily traffic (ADT),

**Total traffic volume in both directions over a 24hour period**

1. Annual average daily traffic (AADT),

**The average daily traffic count in both directions at a given point over a 24hour period based on a one-year count**

1. Reaction Time,

**The time taken by a driver, after a stimulus appears, to perceive a comprehend it in order to decide on the appropriate response and to react accordingly.**

1. Right of Way (ROW), provide neat sketch.

**The width of land acquired for the road, along its alignment.**

[5marks]

1. Equally important as the consideration of horizontal alignment is that of the facility’s vertical alignment. List at least four factors that influence the vertical alignment of highways.

Award one mark for any one of the points listed (maximum 5 points)

* 1. **Existence of horizontal curves**
  2. **Existing and future structures**
  3. **Roadside structures**
  4. **Land use and development**
  5. **Comfort and safety of road users**
  6. **Appearance of the profile alignment**
  7. **Design speed**
  8. **Construction costs**

[4marks]

**QUESTION 2**

1. The following VPI’s are on a road:

|  |  |  |
| --- | --- | --- |
| VPI | SV (m) | Level (m) |
| 1 | 330 | 141.8 |
| 2 | 720 | 158.6 |
| 3 | 1200 | 161.2 |

Given that curve length is 200m at VPI 2, calculate the levels on the curve at 40m intervals

1. **Calculate G1 & G2, award**
2. **Calculate A,**
3. **Calculate K,**
4. **Recall the parabolic equation for vertical curves and rewrite it in the format:**

**And then substitute into the equations for A, L and G1**

1. **Using the equation from Step 4 above calculate the level for point of curvature (PC) and the point of tangency (PT)**
2. **Using the equation from Step 4 above calculate the rest of the levels at 40m intervals,**
3. **Check if the level for the last point on the vertical curve corresponds to the level calculated for PT in step 5 above.**

[17marks]

1. A curving roadway has a design speed of 110 km/hr. At one horizontal curve, the superelevation has been set at 6.0% and the coefficient of side friction is found to be 0.10. Determine the minimum radius of the curve that will provide safe vehicle operation.



**Award 1 mark for correct formula used to calculate R, 1 mark for converting speed to m/s, 1marks for the correct substitution and 1mark for the correct answer and units.**

[4marks]

1. Distinguish between the terms mobility and accessibility citing appropriate examples in each case. Provide a sketch as part of your solution.

**Award 1 mark for each definition mentioned and 2marks for the correct sketch**

**Mobility** is the ease with which vehicles in a traffic stream can continuously travel a desired or free flow speed. Roads with high mobility are characteristic of high speed, while **Accessibility** is the ease with which vehicles can leave or enter a traffic stream and is characteristic of low speeds.

[4 **marks**]

**QUESTION 3**

1. For each correct definition award 2marks
   1. Trip generation,

**The trip generation aims at predicting the total number of trips generated and attracted to each zone of the study area.**

* 1. Trip distribution,

**These generated trips from each zone is then distributed to all other zones within the region based on the choice of destinations (where *I is the trip producing zone and J the trip attracting zone)***

* 1. Modal split,

**The trip matrix or O-D matrix obtained from the trip distribution is sliced into number of matrices representing each mode or in other words Modal Split is concerned with the trip maker’s behaviour regarding the selection of travel mode**

* 1. Trip assignment.

**The process of allocating given set of trip interchanges to the specified transportation system is usually referred to as traffic assignment or generally: it is a process concerned with the trip maker’s choice of path between pairs of zones by travel mode and with the resulting vehicular flows on the multimodal transport network**

[6marks]

1. Table 3.b.1 below represents an existing trip pattern and the growth in traffic for both the Origins and the Destinations. Applying the doubly constrained growth factor method to correct the base year matrix in order to satisfy the future year trip-end constraints.



**Award 16marks for the correct solution, calculations are provided below:**

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[16marks]

1. What is the method applied in Question 3. b) known as?

**Award 1mark for the correct name Furness Method**

[1marks]

**QUESTION 4**

1. What are the functions of a pavement?
   1. **Load bearing,**
   2. **To seal the roadbed from moisture, prevent dust/loss of soil,**
   3. **To provide a smooth surface for a comfortably ride,**
   4. **To provide adequate surface friction or a safe ride**

[4marks]

1. For a rural road located in Matabeleland North Province the following information is available for the design of a flexible pavement:

|  |  |
| --- | --- |
| AADT | 2400 |
| Directional split (2-way DF) | 50/50 |
| Traffic Growth Rate | 2% |
| Proportion of Heavy Vehicles | 15% |
| Average Weight of Heavy Vehicle | 1.5ESA’s |
| Design life | 15years |
| Subgrade Strength, CBR | 3.5% |
| Lane distribution factor | 1 |

For the given design parameters, determine the thickness of the granular layer to be provided above the subgrade [Assumption: A thin Hot Mix Asphalt surface course is to be provided and is assumed to be part of the granular layer].

**Solution:**

𝑵𝑫𝑻 = 𝟑𝟔𝟓 × 𝑨𝑨𝑫𝑻 × 𝑫𝑭 × %𝒂𝒈𝒆𝑯𝑽 × 𝑳𝑫𝑭 × 𝑪𝑮𝑭 × 𝑵𝑯𝑽𝑨𝑮

**Where:**



**CGF = 17.293**

**Then: 𝑵**DT**= 1 704 225.15ESA’s say 1.7MESA’s**

Award **1mark** for each of the above 2 equations mentioned, award another **2 marks** for calculating CGF, award **2 marks** for calculating 𝑵𝑫𝑻

**The procedure below has to be followed to complete the solution to the problem:**

1. **Go to the x-axis of the design chart and locate 1.7MESA’s and draw a vertical line. Award 2marks**
2. **Interpolate between the 3% and the 4% CBR line and draw a line bisector to represent the 3.5% CBR value. Award 2marks**
3. **Where the two lines (from step 1 and 2) intersect draw a horizontal line to intercept the vertical scale to the left of the graph. Award 2 marks**
4. **Read off the value corresponding to the intercept on the y-axis scale on the left hand side of the graph (Thickness of granular Material). This value is the required thickness of the granular material of the design pavement structure to be provided above the subgrade, value should be ±510mm. Award 3marks**

**Optional: is the provision of a capping layer above the subgrade since the subgrade is relatively weak. Award 1mark for mentioning this.**

[15marks]