

Faculty of Engineering Technology

Written Exam	Rail Transport
Teacher	Van Zuilekom, Van Es
Course code	201100013
Date and time	29-6-2015, 13:45-16:45
Location	-not yet known-
Remarks	Closed book, calculator allowed Formulas and tables are, when necessary, are part of the question. Answering in Dutch is allowed

Calculation of the marks for the written exam, C :

$$C = 1 + 9 \cdot \frac{P}{P_{max}}$$

Where P is the sum of points and the maximum number of points is P_{max} .

Available time is 180 minutes. The points per question roughly reflect the time needed for answering the question.

Table of Contents

Question 1 [10 points] Travel time ratio	2
Question 2 [4 points] Load capacity	2
Question 3 [10 points] Radius, speed and cant	3
Question 4 [4 points] Double slip	3
Question 5 [20 points] Zwolle	4
Question 6 [4 points] Platforms	6
Question 7 [4 points] Signal aspects	6
Question 8 [12 points] ERTMS components	7
Question 9 [4 points] Constant warning time grade crossings	7
Appendix: Answering form for Questions 5 and 8	9

Question 1 [10 points] Travel time ratio

On a journey from A to B the travel time ratio ($TTratio$) is defined as travel time divided by public transport ($TT_{publictransport}$) and the travel time by car (TT_{car}):

$$TTratio = \frac{TT_{publictransport}}{TT_{car}}$$

Give comment on the following statements:

- a) [3 points] The $TTratio$ is of limited relevance for share of the choice passenger.
- b) [3 points] The $TTratio$ is of limited relevance for share of the captive passenger.
- c) [4 points] The $TTratio$ is of large importance for share of the public transport operator especially in specific situation.

Illustrate the answers with a graph.



Question 2 [4 points] Load capacity

There is a big difference in the amount of containers carried by one single train in the United States versus one in Europe.

Intermodal goods trains in the United States can carry roughly four to six times the amount of containers compared to Europe.

- a) [2 points] Give two reasons for the difference in load capacity.
- b) [2 points] Explain why European goods trains can't carry the maximum load of a US intermodal goods train.

Question 3 [10 points] Radius, speed and cant

The relationship between speed, radius, acceleration, cant and gauge are given by:

$$\frac{v^2}{R} = a + \frac{(g \cdot h)}{s}$$

Where:

v = speed [m/s]

R = radius [m]

a = acceleration [m/s²]

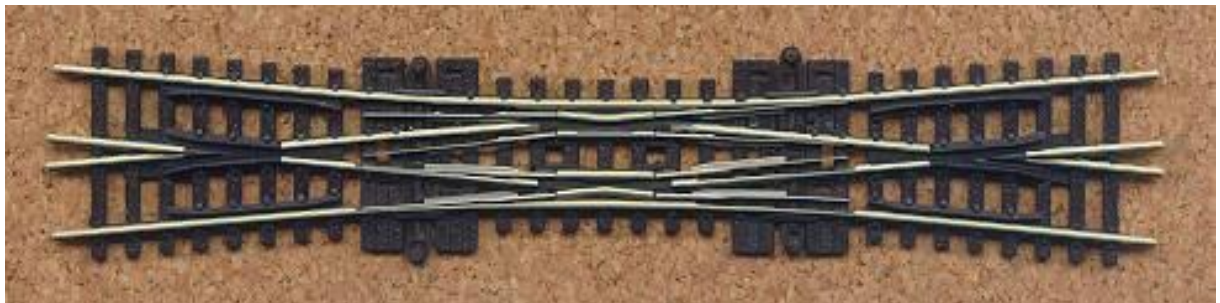
g = gravity constant [9.81 m/s²]

h = cant [m]

s = gauge [m]

- a) [4 points] Explain why cant is of influence on the forces felt by the passenger. Use a drawing of the forces working on a passenger to support the arguments.
- b) [2 points] Explain why in turn-outs the maximum speed of the diverging route is not determined with the formula above.
- c) [2 points] In practice cant is limited. Why is this the case?
- d) [2 points] What is the function of the transition curve? Which variables will change in the transition curve?

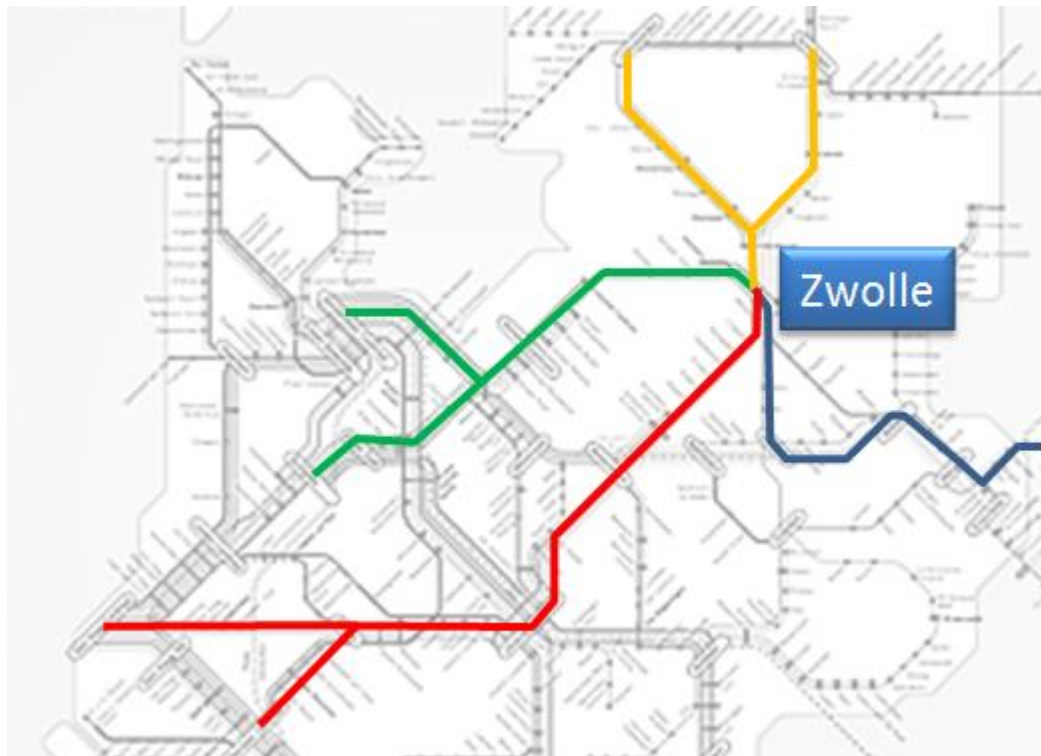
Question 4 [4 points] Double slip



A Double Slip is a specific type of turn-out.

- a) [2 points] Describe it's functionality in terms of regular turn-outs and / or crossings.
- b) [2 points] It has several (dis) advantages. Name two.

Question 5 [20 points] Zwolle



Zwolle station is a very important node in the Dutch railway network. At this station two corridors meet:

1. **The Flevo – North line** link: Amsterdam / Schiphol - Lelystad - Zwolle - Meppel – Groningen / Leeuwarden.
2. **The Veluwe – Jssel Line** link: Den Haag / Rotterdam – Utrecht – Amersfoort – Zwolle – Deventer – Hengelo – Oldenzaal / Germany.

At Zwolle station a specific process takes place. Trains from 4 directions arrive at the same time [1] (see figure below). All trains stop for several minutes to allow passengers to change trains [2].

After a few minutes all the trains depart at the same time [3]. Zwolle is a node with an integrated clock face timetable



[1]



[2]



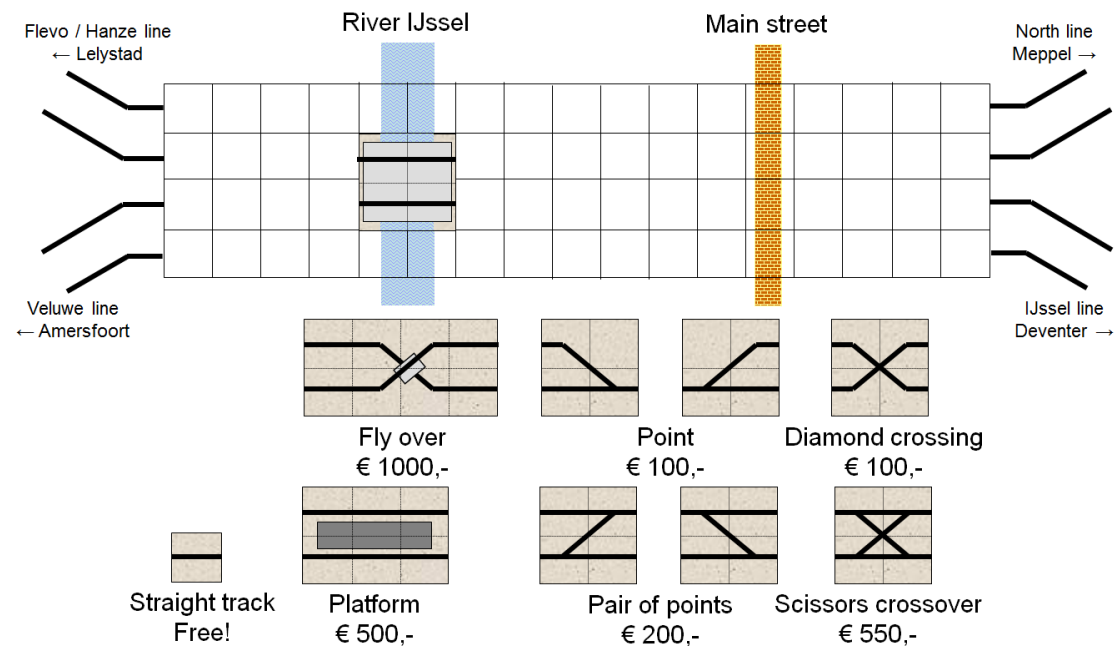
[3]

Every 15 minutes this process takes place.

In between every quarter of the hour, freight trains pass the station. The freight trains run between Rotterdam and Groningen (**Veluwe line – North Line**).

The station of Zwolle will be completely rebuild. The requirements are:

- The new station must be connected to Main street (the platform must overlap Main street at some point).
- A cross platform change between the two lines. One in the west – east (left – right) direction and one in de east – west direction.
- Trains from all 4 directions must arrive independently at the same time.
- All trains must depart independently in 4 directions.
- Freight train movements from and to Rotterdam - Groningen must have independent routes so they can pass the station Zwolle at the same time.



Restrictions:

- There is already a double track bridge across the river IJssel. It is not possible to build an extra bridge.
- Stay inside the checkerboard.
- Use only standard elements.
- Don't spend more money than necessary.

Note 1: It is allowed to rotated or mirror an element.

Note 2: there is an answer form attached to this exam.

Question 6 [4 points] Platforms

The requirements for a platform are:

- a gradient of less than 1‰ and;
- a horizontal curve with a radius of at least 15000 meter.

Explain why.

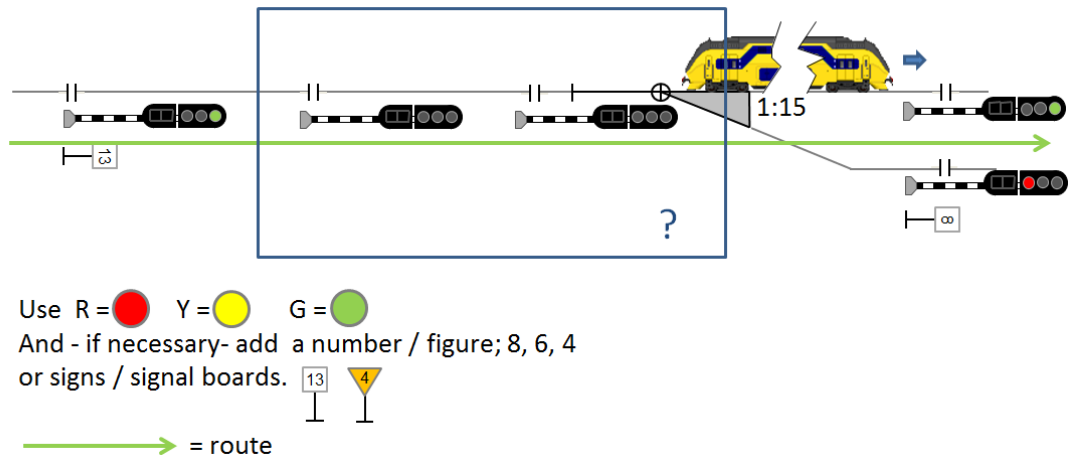
Question 7 [4 points] Signal aspects

Complete the schemes with the missing signal aspects. And, if applicable, add speed indication.

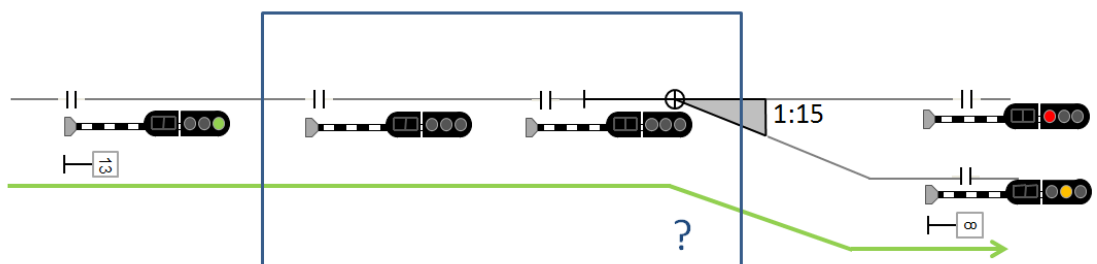
N.B. the distance between two signal posts is always sufficient for the braking curve.

Turn out 1:15 Vmax 80 km/h.

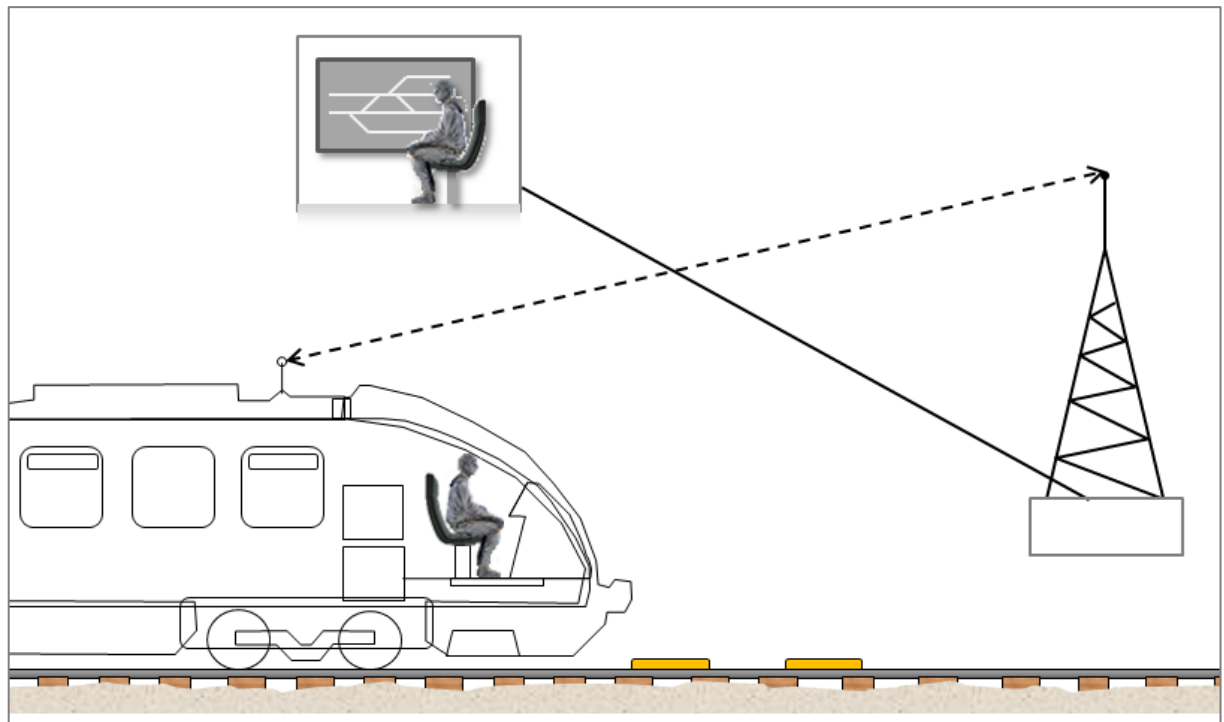
a) [2 points]



b) [2 points]



Question 8 [12 points] ERTMS components



- a) [6 points] Where are the following six components of ERTMS located in the picture above? Use the answering form in the appendix of this exam to answer the question.
1. DMI (Driver Machine Interface)
 2. Eurobalise
 3. GSM-Rail
 4. IXL (interlocking)
 5. RBC (Radio Block Centre)
 6. STM (Specific Transition Module)
- b) [6 points] What is the function of these six ERTMS components (the list in above) within ERTMS-system?

Question 9 [4 points] Constant warning time grade crossings

ERTMS has a so called 'constant warning time' option in regard to grade crossings.

- a) [2 points] Explain the difference with infrastructure based automatic grade crossings.
- b) [2 points] Describe the advantages of constant warning time.

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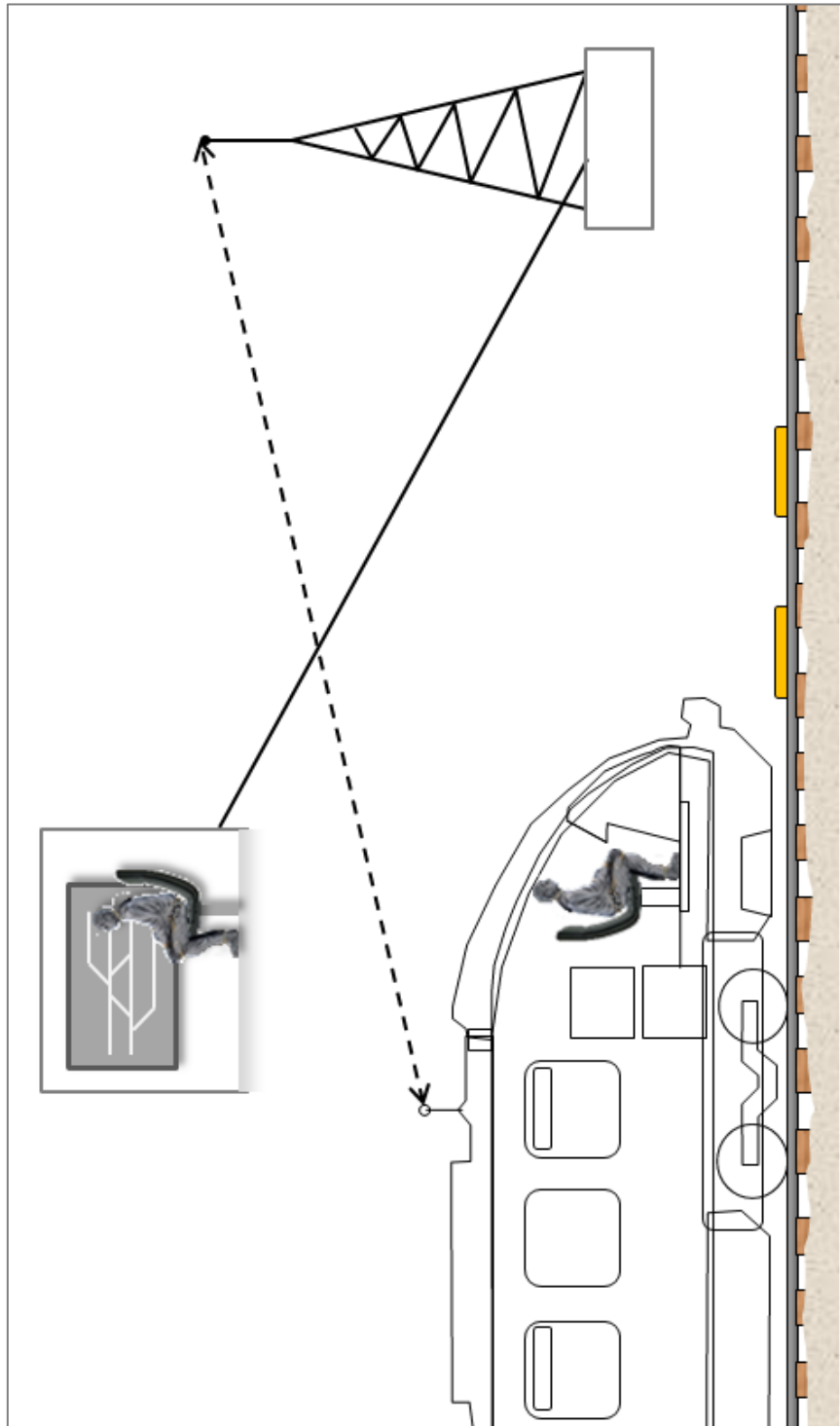
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Appendix: Answering form for Questions 5 and 8

Name: _____

Student number: _____

Question 8



Question 5

