

Faculty of Engineering Technology

Written Exam	Rail Transport
Teacher	Van Zuilekom, Van Es
Course code	201100013
Date and time	13-04-2016, 13:45-16:45
Location	CR 2N
Remarks	Closed book, calculator allowed Formulas and tables are, when necessary, are part of the question. Print in colour

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.

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Question 1 [6 points] Trains with cars, trailers, trucks



In the illustration above you see 6 trains who all have something to do with transporting cars, trailers, trucks.

Describe for each kind of train which product – market combination do they represent?

Question 2 [12 points] Times change



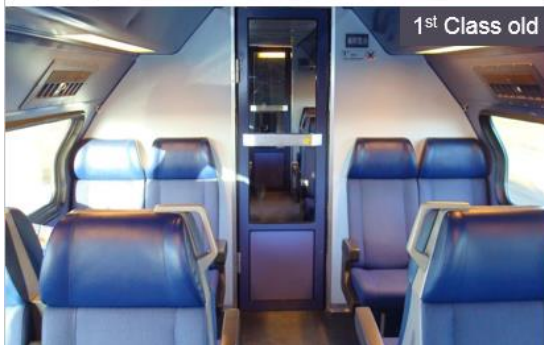
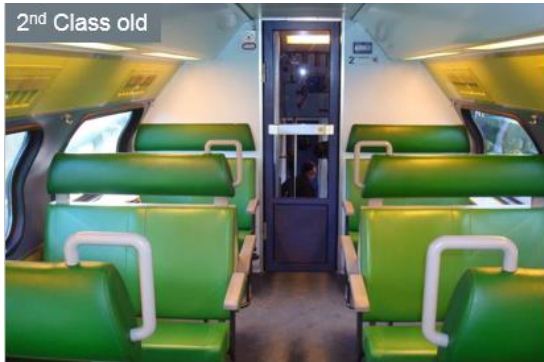
↑ A 1980 double-deck suburban push – pull train set

Around 1980 the double-deck suburban push – pull train sets were introduced to meet the increasing demand for commuter services in the Randstad (cluster of major cities in the Netherlands). 30 years later they got a 'midlife update' and are completely modernized and refurbished.

Nowadays they are used for another product – market combination.



↑ The 2016 version



- a) [6 points] Explain why this train set is no longer suitable for all station services in the Randstad. Motivate your answer.
- b) [6 points] Explain the difference in interior and describe the old and new product – market combination. Motivate your answer.

Question 3 [12 points] Air brake system

The air brake system was invented more than 100 years ago and it is still in use today

- a) [4 points] Describe why the air brake system is a so called 'fail safe' system.
- b) [4 points] Describe why it takes more time to release the brakes of a freight train compared to a passenger train.
- c) [4 points] Describe why a single wagon or group of wagons (without a locomotive) can't be considered safely 'parked' only depending on the air brake system.

Question 4 [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 5 [8 points] Turnouts

- a) [4 points] Explain the difference between 'left- and right hand turnouts' and 'Left- and right routing'.
- b) [4 points] Define the turnout in the below illustration in terms 'left- and right hand turnouts' and 'Left- and right routing'.



Question 6 [8 points] Train detection

There are several (technical) solutions to determine the position of a train.
Name two and describe how they work.

Question 7 [3 points] Signal aspects

Complete the schemes with the missing signal aspects 1, 2 and 3. And, if applicable, add speed indication.

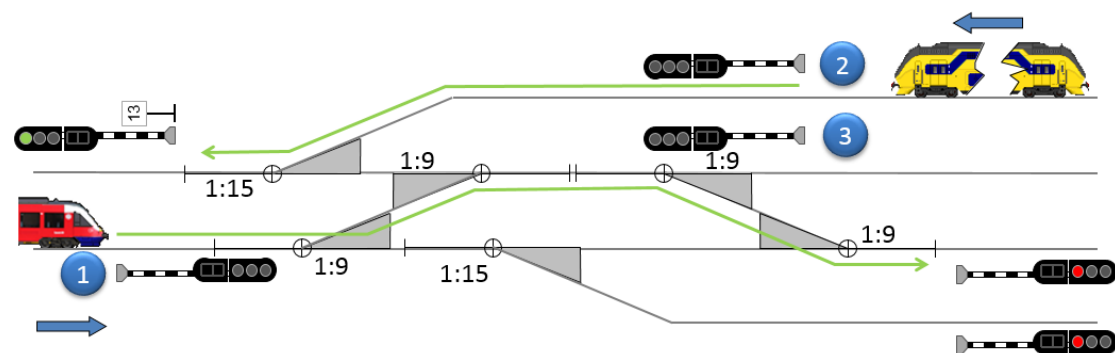
N.B. the distance between two signal posts is always sufficient for the braking curve.

Turnouts / switches

1:9 = Vmax 40 km/h

1:12 = Vmax 60 km/h

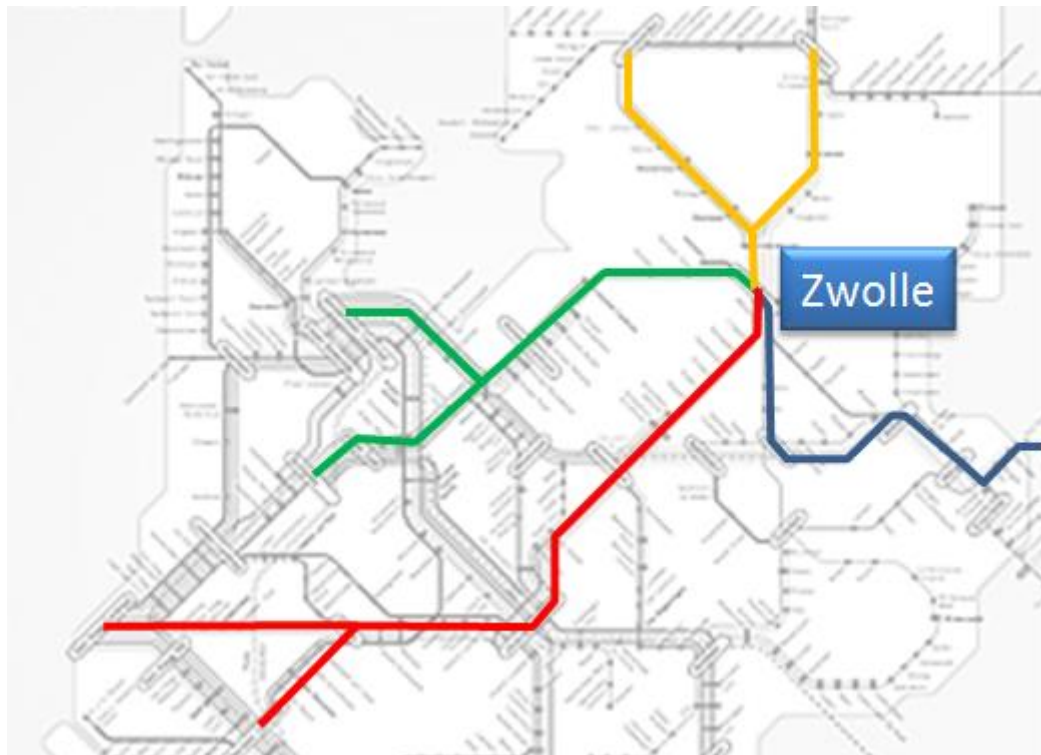
1:12 = Vmax 80 km/h



Use R =  Y =  G = 
And - if necessary- add a number / figure; 8, 6, 4
or signs / signal boards.

 = route

Question 8 [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 – IJssel 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]



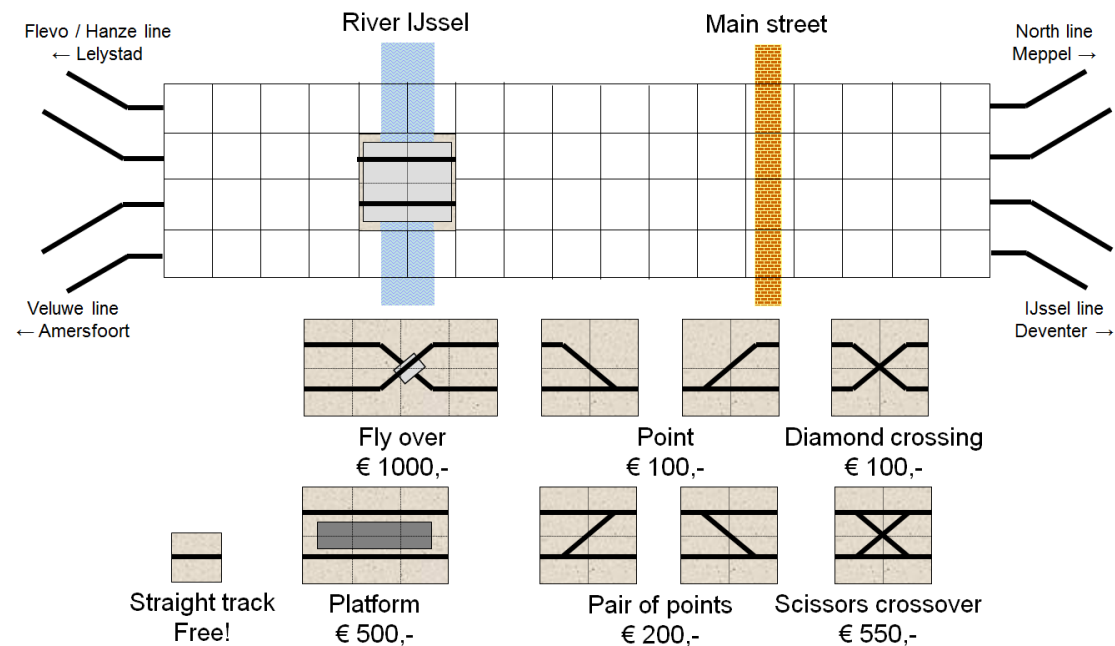
[3]

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 (use as many as you need and rotate or mirror them if necessary)
- Don't spend more money than necessary.

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

Question 9 [8 points] Track concepts



The photo above shows a so called 'Fully integrated track'.

Give 4 dominant characteristics of this track concept. Let for each characteristic know to what extent this characteristic is positive or negative.

Question 10 [9 points] Crossing waterways

Sometimes railroads have to cross waterways (canals, rivers) used for inland shipping or boating.

- a) [3 points] Describe three most common used solutions.
- b) [6 points] Give of every solution one advantage and one disadvantage.

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Appendix: Answering form for Question 8

Name: _____

Student number: _____

