

Written Exam in
Internetworking
TSIN02

18th January 2025 14:00 - 18:00

Location:	R43
Examiner:	Harald Nautsch
Teacher:	Harald Nautsch, 1361
Department:	ISY
Module:	TEN1
Number of problems:	11
Number of pages:	8 + formula collection
Permitted equipment:	Calculator with empty memory, TSIN02 formula collection, general English dictionaries without notes
Grades:	3 : 25-32 points 4 : 33-41 points 5 : 42-50 points
Other:	Answers can be in English or Swedish. The teacher will visit around 16:00.

1 **Link layer**

- a) Why is packet switching the more common choice for modern times?
(1 p)
- b) What is a MAC address?
(1 p)
- c) Explain the main difference between forward error correction (FEC) and automatic repeat request (ARQ).
(1 p)
- d) Why are wireless access networks divided into physical subspaces called cells?
(1 p)

2 **Transport and application layers**

- a) What is used in addition to the IP address in the socket layer for addressing?
(1 p)
- b) The two most common transport layer protocols used are TCP and UDP. What are the differences between the two protocols?
(2 p)
- c) Explain what DNS is and briefly describe how it works.
(2 p)

3 Optical networks

- a) Why is 1550 nm the preferred operational wavelength for optical communication systems?
(1 p)
- b) Name the main advantage of using optical amplifiers instead of optical/electrical/optical converters.
(1 p)
- c) What is a lightpath?
(1 p)
- d) What is the main difference between an optical amplifier and a full regenerator?
(2 p)

4 Network Economics

- a) Why is flat rate considered unfair?
(1 p)
- b) Name one advantage for time dependent pricing for the telecom operator and one for the users.
(2 p)

5 Data centers

- a) In the case of cloud networks, why is a simple inverted tree structure not scalable for growth? What should be used instead?
(2 p)
- b) From the point of view of a company, name one advantage and one disadvantage of moving computing resources to the cloud.
(2 p)

6 Security

a) Why is DNSsec more secure than standard DNS? Why is it complex to implement in practice?

(2 p)

b) What is cache poisoning?

(1 p)

c) What is a TCP SYN flood attack?

(1 p)

7 Optical Networks

In the following tables, different commercial elements of an optical network are shown.

Sources		
Laser A	0.1 mW	2500 SEK
Laser B	0.5 mW	3500 SEK
Laser C	1 mW	4250 SEK
Receivers		
Photodetector A	Sensitivity = -22 dBm	3000 SEK
Photodetector B	Sensitivity = -27 dBm	4500 SEK
Photodetector C	Sensitivity = -35 dBm	6000 SEK
Amplifiers		
Amplifier A	Gain = 10 dB	3000 SEK
Amplifier B	Gain = 20 dB	4000 SEK
Amplifier C	Gain = 30 dB	6000 SEK

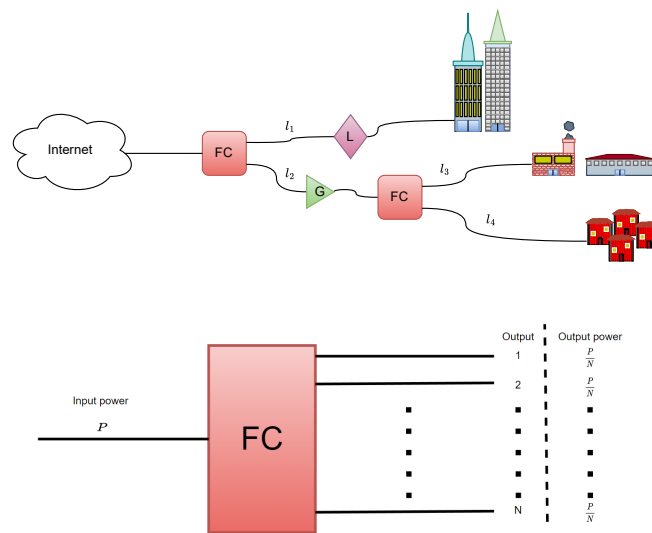
We will ignore the effects related to dispersion or other non-linear effects and we need the power for a correct analysis of the whole problem.

We want to build an optical link of 115 km with an optical fiber that has an attenuation coefficient $\alpha = 0.2$ dB/km. Propose the necessary elements to make this network possible. The best design must consider the lowest monetary cost and must make sure that a proper connection is achieved (the receiver should receive the signal without any problems).

(4 p)

8 Optical Networks

You have been given the task to design an optical network. The suggested design is described in the figure. In this design, the network should reach three different areas, a city center, an industrial area and a suburban area. The optical signal is divided with the help of fiber couplers (FC) that splits the power into different paths according to the figure. The lengths of the fibers are $l_1 = 110$ km, $l_2 = 70$ km, $l_3 = 50$ km and $l_4 = 25$ km. There are some extra losses to the city on length l_1 which are $L = 10$ dB and there is an amplifier to the industrial area and suburban area that. This amplifies the signal with $G = 4$ dB. The input power to the first fiber coupler is $P_{in} = 0.5$ mW and the operating wavelength is 1550 nm, giving an $\alpha = 0.2$ dB/km.



- a) Decide how sensitive the photodetectors (at least) should be at the receivers in order to receive the signal properly.

(3 p)

- b) The optical system is built, but upon further investigations from a technician, the attenuation constant α for the fiber l_1 is different than the others. It turns out that $\alpha = 0.6$ dB/km in this optical fiber. What can we do to compensate these losses? Give at least two suggestions.

How much are the losses in the optical fiber l_1 now? (Disregard the extra losses L)

(3 p)

9 Internetworking

An ISP is granted a block of addresses starting with 150.30.0.0 / 16 for the three areas in problem 8. The ISP wants to distribute them to 800 customers as follows:

- 1st group has 150 large size businesses; each needs 256 addresses.
- 2nd group has 250 medium size businesses; each needs 64 addresses.
- 3rd group has 400 Households; each needs 10 addresses.

a) Design the sub-blocks and give the slash notation for each sub-block. (Find the first and the last IP addresses on each group).

(4 p)

b) Find out how many addresses after these allocations will be available for the ISP.

(1 p)

c) One of the large sized business in the first group wants to internally divide their 256 addresses into 4 subblocks. Is this possible? If not, why? And if it is possible, what would those subblocks look like?

(2 p)

10 Source/channel modelling

A network you have designed has some packet losses that need to be considered when coding for the network. The loss bursts follow the Gilbert-Elliott process and the probability of a lost package given that the previous packet was received is $p_{l|r} = 0.07$ and the probability of a received package given that the previous package was lost $p_{r|l} = 0.45$. The amplitude range of the signal is $[-5, 5]$ and the receivers use uniform quantization with 30 reconstruction levels. Assume that we are working in the high-rate regime, that we are not using any protection against lost packages and that the MSE distortion is 1 if no packet arrives at the receivers.

a) What is the stationary channel loss probability?

(1 p)

b) What is the distortion if the packet arrives?

(1 p)

c) What is the overall stationary mean MSE distortion considering the channel loss probability and the quantization distortion?

(1 p)

11 Network Economics

In order for the ISP to decide what the pricing of the service should, a survey was sent out to the users in order to see how much they use and what they would be happy to pay for. They come to the conclusion that they have two types of users (a heavy consumer and a light consumer) and their demand functions can be described as:

$$D_1(p) = -\frac{1}{15}p + 12$$

$$D_2(p) = -\frac{1}{45}p + 4$$

The ISP also decides that the customers should pay 60 SEK/GB. Assume that the underlying utility function (for both groups of customers) is concave; that the derivative of the utility function is invertible; and that the utility function evaluated for 0 GB is 0.

- a) Calculate the net utility for both types of customers using user-based pricing.

(2 p)

- b) Calculate the net utility for both types of customers using flat rate pricing.

(2 p)

- c) How should the ISP price their services in order to keep both of the user types happy? Motivate your answer!

(1 p)