Exam for:
Multimedia and Video Communications (SSY 150) - June 1, 2020

Dept. of Electrical Engineering, Chalmers Univ. of Technology,
Examine date and time: 1 June, 2020, 10:00am -12:00am

Lecturer and Examiner: Prof. Irene Gu

This written exam may yield a maximum of 22 points.

The total exam yields 100 points (where 3 laboratory work yields a maximum 65 points, and oral discussion maximum 5 points, quiz's maximum 8 points)

To pass the examination, a minimum of 50 points is required.

Grades are defined as follows:

TOTAL points (p)	Grade:
$p < 50$	Fail;
$50 \le p < 70$	Pass with grade 3;
$70 \le p < 85$	Pass with grade 4;
$p \ge 85$	Pass with grade 5.

Aids allowed:
- The mathematical handbook 'Beta'.
- A double sided A4 pages with formulae and notes of your own choice.
- A calculator (any type).

Success and good luck!

Problem 1 (multiple choices) **(6p)**

1. For a clean speech signal (without background noise), what is the minimum **spectral peaks** required to characterize the speech signal? What is the corresponding LPC model order under your choice?

   Spectral peaks: ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ other numbers (specify)

   LPC model order ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ other numbers (specify)

2. Which of the speech compression methods below are/is model-based methods?

   ☐ LPC ☐ CELP ☐ Subband filters ☐ damped sinusoids

3. If a source packet contains 11 symbols, and 5 parity symbols are added by the RS codes,

   (a) How many symbol errors can be corrected by the above RS codes?

   ☐ 11 ☐ 9 ☐ 8 ☐ 7 ☐ 6 ☐ 5 ☐ others (specify)

   (b) How many symbol errors can be detected by the above RS codes?

   ☐ 11 ☐ 9 ☐ 8 ☐ 7 ☐ 6 ☐ 5 ☐ others (specify)

4. What is the **main factor** that enables one to achieve a high compression rate of **video**?

   ☐ remove small DCT coefficients ☐ quantization of zigzag obtained 1D sequence
   ☐ motion compensation ☐ intra coding ☐ others (specify)

5. According to the theory on erasure networks, applying matrix interleaver might be able to influence the received **packet loss** errors, with the following reason(s):

   ☐ no, no influence ☐ yes, reduces packet loss when combining with channel coding
   ☐ yes, always reduces packet loss ☐ Others (specify)

6. According to the theory for additive Gaussian white noise channel, applying matrix interleaver could reduce/increase the received packet loss errors **due to bit errors** in the physical layer, with the following reasons:

   ☐ no, no influence ☐ yes, reduced packet loss when combining with channel coding
   ☐ yes, definitely reduced packet loss ☐ Others (specify)

7. Which layer of the TCP/IP communication model that a packet loss may occur?

   ☐ physical layer ☐ transport layer ☐ data link layer
   ☐ Internet layer ☐ Others (specify)

8. Which of the following are video codecs?

   ☐ AVC ☐ JPEG ☐ AMR ☐ EVS ☐ VVC

9. By introducing 5G we expect improvements on

   ☐ latency ☐ macroblocks ☐ throughput ☐ battery life ☐ quantization

10. For comparing image quality, chose one of the following objective quality measure that you think is the best:

☐ MMAE ☐ MMSE ☐ PSNR ☐ Mean SSIM ☐ others (specify)

11. For real time transport compressed video, which protocol(s) is better?

☐ TCP ☐ UDP ☐ TCP +IP ☐ UDP+IP ☐ Others (specify)

12. For video-streaming, which protocol(s) is better?

☐ TCP ☐ UDP ☐ TCP +IP ☐ UDP+IP ☐ Others (specify)

Problem 2. Brief answer/simple questions **(6p):**

2.1. (1p) Compression of speech signals: In speech signal coding and compression, a speech signal sequence is usually divided into blocks (for example, 10ms for each block) where compression is then applied to each block of speech. Briefly describe the reasons on why this is applied.

2.2 (2p) A sequence of symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, is sent for packetization. The packet size is chosen as 4.

(a) Write down the contents of each packet after the packetization.
(b) Write down the contents of each packet that being sent to the network if matrix inter-leaver is applied.
(c) Write down the contents of each packet that being sent to the network if matrix inter-leaver is applied.

2.3 (3p) Suppose motion compensation (MC) in video is done by using a block matching technique through *local searching*, to trade off the computational cost and reconstructed MC video quality. Assuming 80% of the motion vectors should be best/optimally compensated, describe the method you can determine the best local searching area size in the block matching?

Problem 3. (10p) Consider a packet video transmission system. In our system, a video packet is considered as lost if any of the following cases occurs:

(i) The packet (or, one part of a packet) is lost during the transmission;
(ii) The packet is received however with an excessive delay (delay time > a maximum allowed time);
(iii) The packet is lost, if at least one bit error occurs in the physical layer cannot be corrected.

In the system, **we assume that:**
Each packet contains C codewords, each codeword is obtained from encoding S symbols, and each symbol contains B bits, also a symbol error occurs if there is at least *1 bit error in a symbol* cannot be corrected.

Some notations used are defined as follows:

- the probability due to (i) as ρ_k ;
- the probability due to (ii) as v_k;
- the probability of bit error in a symbol as p_b.
- the probability of codeword error due to symbol error as p_c ,
- the probability of symbol error due to bit error in (iii) as p_s,

You are asked to solve the following problems:
(a) Write down the probability (in mathematical expression) for *k*th packet loss, P_k , that is due to (i), (ii) and (iii), separately. Also, write down the total probability of *k*th packet loss due to these 3 reasons.
(b) Assume $\rho_k = 0.015,\ v_k = 0.001,\ p_b = 0.001$, each packet contains *M*=8 codewords, each codeword contains *C*=16 symbols, and each symbol contains *b*=12 bits. Compute the probability value that the *k*th packet is lost, P_k, due to (i), (ii) and (iii).
(c) What is the total packet loss probability from the results in (b)?