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Problem 1: Multiple-choice (20 points – 10 questions 2 points each)

1. **Isochronous Transmission Model** provides
   a. Communication without any timely restrictions;
   b. Communication with upper bound on end-to-end for each packet of a data stream;
   c. Communication with upper bound on end-to-end delay and minimal jitter delay for each packet of a data stream;

   Answer: C

2. **Audio sample values** 0, 0.25, 0.36, 0.50, 0.75, 0.65, 0.2, -0.4, -0.6, -0.45, -0.23, 0 require how many bits for encoding the values:
   a. 3 bits;
   b. 4 bits;
   c. 5 bits;

   Answer: B

3. **Noiseless 6KHz channel** cannot transmit a signal of four discrete levels at a rate exceeding
   a. 24 000 bits per second;
   b. 12 000 bits per second;
   c. 6 000 bits per second;

   Answer: A

4. **Color encoding** uses during the transmission
   a. Two luminance signals and one chrominance signal;
   b. Red, green and blue signals;
   c. One luminance and two chrominance signals;

   Answer: C

5. To avoid **Flicker effect**, we need to
   a. Increase the pixel resolution;
   b. Increase the refresh cycles per second;
   c. Increase the memory in the display refresh buffer;

   Answer: B

6. **HDTV differs from NTSC** video signal because of
   a. Different number of lines only;
   b. Different frame rate and aspect ratio only;
   c. Different number of lines, frame rate and aspect ratio;

   Answer: C

7. **MPEG-2 compression** belongs to
   a. Entropy coding schemes;
   b. Hybrid coding schemes; ;
   c. Source coding schemes;

   Answer: B

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8. **Retrieval mode applications** need
   a. Symmetric compression;
   b. Asymmetric compression;
   c. None of the above;

   Answer: B

9. Applying a **fixed-length compression technique**, consider the following original string of length 37 characters: 3340020005500044440000000006005000004. Which technique yields better compression?
   a. Run-Length Coding;
   b. Zero-suppression Coding ;
   c. Huffman Coding
   d. Arithmetic Coding;

   Answer: B

10. We wish to transmit a message using 9 symbols. Let us assume **fixed-length coding**. What is the smallest number of bits per symbol?
   a. 3 bits;
   b. 4 bits;
   c. 5 bits;

   Answer: B

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Problem 2 (20 Points)

1. (10 Points) Explain the **differences** between **JPEG compression and MPEG-1 compression**. Provide at least five differences between these two compression schemes.

- JPEG is image compression alg., MPEG-1 is video compression
- JPEG applies to any size of images, MPEG-1 applies only to selected set of sizes
- JPEG consider MCUs, MPEG-1 does not
- JPEG uses quantization tables, MPEG-1 does not
- MPEG-1 considers also compression via prediction, creating P and B frames, JPEG does not.

2. (10 Points) Consider the compression pattern of MPEG-2 encoded frames: IPBPBPI.
   a. (4 Points) Explain what is the difference **between P frames and B frames**?

P frames consider only past prediction alg., and use past frame for compression.

B frames consider past and future frames for compression.

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b. (2 Points) Explain for what kind of **applications** MPEG-2 is suitable and for what kind of applications MPEG-2 is not suitable.

MPEG-2 is suitable for Retrieval apps, where videos are stored/compressed ahead of time. The decompression during retrieval is fast. MPEG-2 is not suitable for conversational applications.

c. (4 Points) Specify the **decoding order** of the compression pattern **IPBPBPI** of the MPEG-2 frames before they get displayed. Explain clearly why the order is as you specify.

IPBPBPI is the display order

IPPBPBI is the decoding order.

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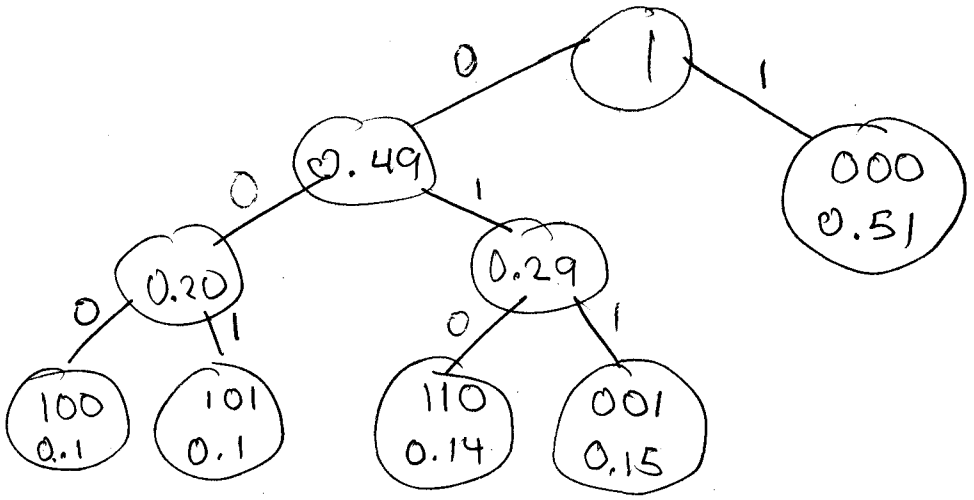
Problem 3 (20 Points)

Let the alphabet **A** be A=(100, 110, 000, 101, 001). Let the occurrence probability be P(100) = 0.1, p(110) = 0.14, p(000) = 0.51, p(101) = 0.1, p(001) = 0.15 (Note: Assume that you label left branches with 0 and right branches with 1 in the Huffman Tree.)

1. (5 Points) Create the **Huff man Binary Tree** for the alphabet set **A**.



2. (5 Points) Fill in the **Huffman table**

Alphabet A	Huffman Code
100	000
110	010
000	1
101	001
001	011

3. (5 Points) **Decode** the following stream (from the Huffman code to alphabet A): **1110010110001**, using the Huffman tree and table from problem 3.1 and 3.2. Show your work of decoding.

1	1	1	001	011	000	1
↓	↓	↓	↓	↓	↓	↓
000	000	000	101	001	100	000

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Problem 4 (20 Points)

Consider uncompressed video with 320x240 pixels video frames, 24 bits per pixel resolution, 25 frames per second. Consider that the video is going to be sent over the transport protocol, where the body size of the transport packet 9 Kbytes. **Assume that the video application puts a header of 12 bytes in from of each video frame** (consider that the M_A- application packet consists of (a) the **application payload**, which is a video frame, plus (b) the **application header** where all kinds of application metadata are stored such as frame rate, type of video coding, size of frame, and others).

1. (15 Points) Translate the video characteristics into the network QoS parameters, i.e., compute (a) the transport packet rate R_N (in packets per second), (b) transport bandwidth B_N (in bits per second), and (c) the packet inter-arrival time P_N (in ms) at which the uncompressed video will be sent into the network via this transport protocol.

$$R_N = \left\lceil \frac{M_A}{M_N} \right\rceil \quad R_A = \left\lceil \frac{320 \cdot 240 \cdot \frac{24}{8} + 12}{9 \cdot 1024} \right\rceil 25 = 650$$

$$B_N = \frac{(9 \cdot 1024)}{M_N} \; \frac{650}{R_N} = 5.7 \text{ MBps}$$

or

45.7 Mbps

$$P_N = 1/R_N = 1.54 \text{ ms}$$

2. (5 Points) If we assume that the network loses two transport packets per second, what is the maximum number of video frames per second that the application can expect to lose? (Note: Assume that the transport protocol does not retransmit the packets, i.e., any loss of transport packets will impact the application frames.) Explain your result.

Since this is uncompressed sequence of frames, 2 video frames could be lost if two transport packet get lost within a second.

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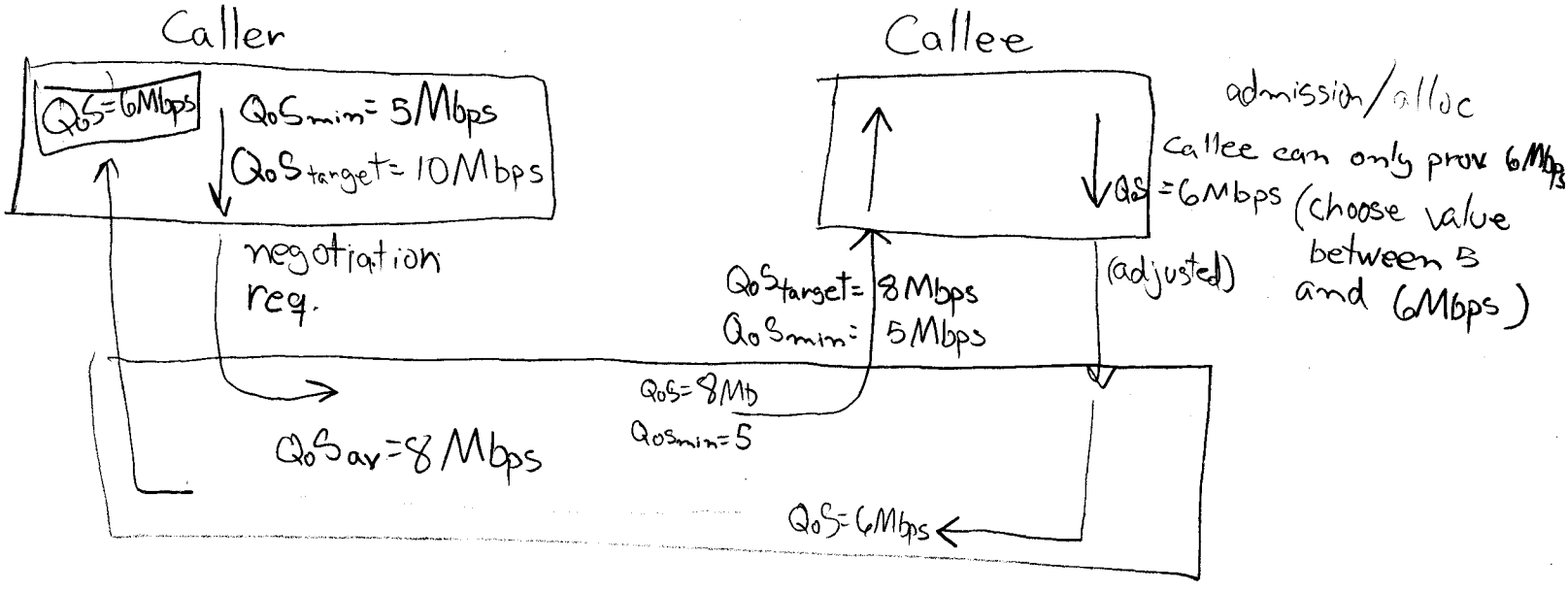
Problem 5 (20 Points)

Consider a caller (sender) and callee (receiver) communicating over a network service provider which has the capabilities to modify proposed QoS parameters. Let us assume that the caller wants minimal bandwidth of 5 Mbps and target value of 10 Mbps. The network has currently available 8 Mbps and the callee has 6 Mbps bandwidth availability.

1. (10 Points) Explain the **negotiation protocol** between the **caller, callee and the network service provider**, how these parameters are exchanged, and provide the end result how much bandwidth will be used after the negotiation protocol is executed. Show your work who is communicating with whom using what QoS parameters.



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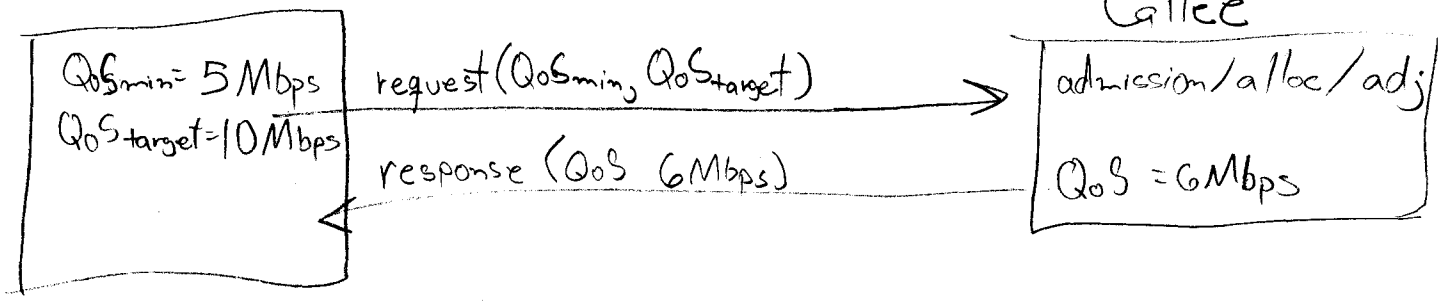
2. (10 Points) What would happen to the **negotiation protocol** if the network service provide would not have the capabilities of modifying proposed QoS parameters? Show how the negotiation protocol would look like and explain what would be the end-result of the negotiation in this case?

We would have p2p negotiation



End result= 6 Mbps

it satisfies the QoS min and the reserve available at caller and callee sites