1. Topic: Fundamentals of Audio and Video Coding (20 marks)

a) Describe using an example how an analogue audio signal is digitised. (4 marks)

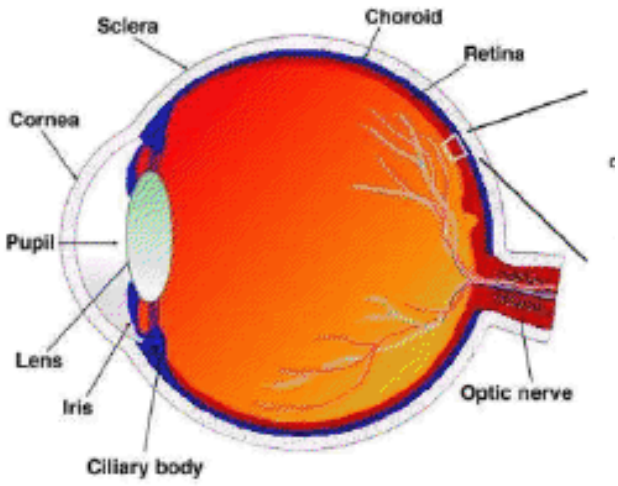
- Answered in Sample-12.

b) Describe using an example how a digital signal is quantised. (4 marks)

- Linear and Nonlinear Quantisation
- Linear format typically stores samples as uniformly quantised values
- Non-uniform quantisation uses more finely-spaced levels where humans hear with the most acuity
- Nonlinear quantisation works by first transforming an analogue signal from the physical space into a theoretical space and then uniformly quantising the resulting theoretical space values e.g. μ-law encoding.

c) Describe using a diagram, an image formation model. (4 marks)

- The lens focuses an image onto the retina, which is upside-down and left-right reversed.
- The retina consists of an array of rods and three kinds of cones
- The rods come into play when light levels are low and produce an image in shades of grey
- The three kinds of cones are most sensitive to red (L), green (M) and blue (S)



d) Describe briefly the colour model used for digital video. (4 marks)

- YCbCr is a scaled and offset version of the YUV color space.
- YCbCr is one of two primary color spaces used to represent digital component video (the other is RGB). The difference between YCbCr and RGB is that YCbCr represents color as brightness and

two color difference signals, while RGB represents color as red, green and blue. In YCbCr, the Y is the brightness (luma), Cb is blue minus luma (B-Y) and Cr is red minus luma (R-Y)

e) What is meant by the term deinterlacing? Briefly describe two deinterlacing techniques. (4 marks)

- Not covered.

2. Topic: MPEG Standards (30 marks)

a) For MPEG-1 video describe how

i. intra-frames are encoded (6 marks)

- Answered in Summer-12.

ii. A good match for motion estimation is calculated. (4 marks)

- Use a motion vector to identify where the parts of the image in the target frame were located in a reference frame
- Look for a match between the macroblock in the target frame and the most similar part of previous and/or future frame(s) known as Reference frame(s)
- The displacement of the reference block against the target macroblock is called a motion vector
- Motion estimation is a computationally intensive operation
- The amount of motion is recorded by the motion vector
    - Forward motion vectors are matches with previous frames
    - Backward motion vectors are matches with future frames

b) For MPEG-4

i. Describe the steps involved in VOP-based motion compensation. Note a VOP is a Video Object Plane. (8 marks)

- Not covered.

ii. What is an alpha-map? (2 marks)

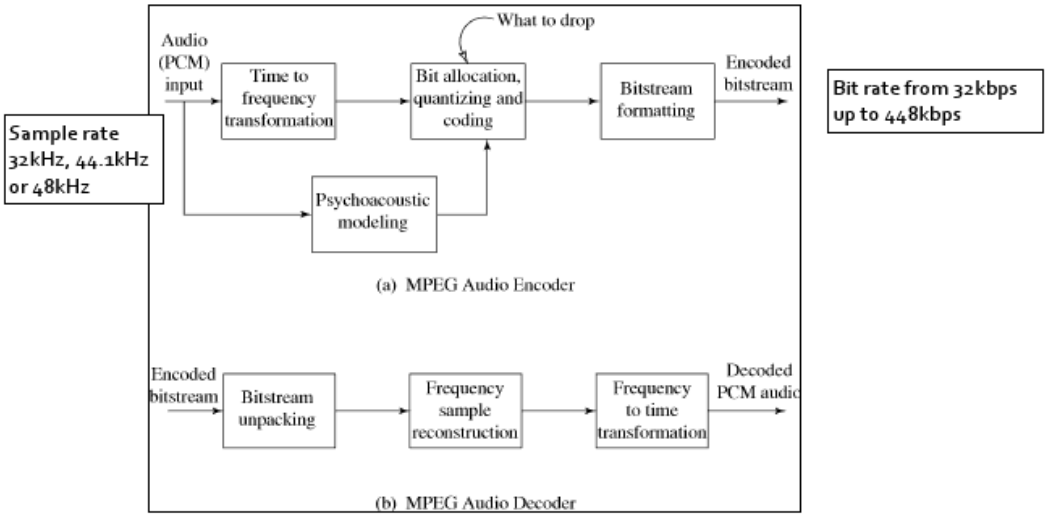
- Not covered.

c) For MPEG audio

i. Describe how psychoacoustic techniques are used to compress audio. (6 marks)

- The threshold of hearing rises when multiple sounds come to the human ear
    - Loud sounds mask quieter sounds at nearby frequencies (Frequency Masking)
    - Loud sounds mask other sounds for a period of time (Temporal Masking)
- These phenomena can be exploited when encoding and compressing audio e.g. by means of Frequency Masking, Temporal Masking
- Frequency Masking: Lossy audio data compression methods remove some sounds which are masked. A lower tone can effectively mask (make us unable to hear) a higher tone, but a higher tone does not mask a lower tone. The greater the power in the masking tone, the wider is its influence
    - The broader the range of frequencies it can mask
    - So if two tones are widely separated in frequency then little masking occurs
- Temporal Masking: After a loud tone the ear requires time to recover. The longer a masking tone is played, the longer it takes before a test tone can be heard.

ii. Illustrate using a diagram the basic MPEG Audio encoder and decoder. (4 marks)



3. Topic: Multimedia Distribution (30 marks)

a) Explain what is meant by streamed multimedia content. (4 marks)

- Answered in Sample-12.

b) Explain the steps a client must follow in order to display a presentation using RTSP. (6 marks)

- Not covered.

c) Explain the role of an MPEG-4 hint track. (4 marks)

- Not covered.

d) Describe how Quality of Service can be improved when using best-effort networks, such as the Internet, for multimedia delivery. (6 marks)

- By utilising any or all of the following
    - RSVP: signalling for resource reservations
    - Differentiated services: differential guarantees
    - Integrated Services: firm guarantees

e) Describe a scheme for recovering from packet loss. (6 marks)

- Answered in Sample-13.

f) Explain how damaged macroblocks can be estimated. (4 marks)

- Motion-compensated temporal interpolation: copy the corresponding macroblocks from the previous frame.
- Spatial interpolation: interpolate pixel values from pixels in adjacent correctly received macroblocks.