



MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2021/2022 ACADEMIC YEAR

**FOURTH YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF
TECHNOLOGY IN ELECTRICAL AND ELECTRONICS ENGINEERING**

EET417: DIGITAL BROADCASTING

DURATION:2 HOURS

Instructions to candidates:

1. Question One is compulsory
2. Attempt any other Two questions
3. Mobile phones are not allowed in the examination room
4. You are not allowed to write on this examination question paper

SECTION A

QUESTION ONE

- a) State the difference between progressive and interlaced scanning (2 marks)
- b) A video is compressed at the rate of 3.2 Mbps with 4:2:2 colour representation. Determine the rate if it is transformed to 4:2:0 while keeping everything else the same. (3 marks)
- c) State the advantage of MPSK over M-QAM (1 mark)
- d) The specifications of a TV program are as follows: 1080p, aspect ratio 16/9, 60 frames per second, 4:2:0, 8 bits per pixel.
- Find the bit rate required to transmit this signal as is (uncompressed). (4 marks)
 - Find the duration of this program (in minutes) that can be stored on a DVD disc with a capacity of 50 Gigabytes. (3 marks)
 - Assume that the frames are divided into GOP as IBPBIBPBI.... and compressed. Assume that the compression ratio for I, P, and B frames are 1/30, 1/50, and 1/100 respectively. Find the bit rate required to transmit this compressed signal. (4 marks)
- e) An 8x8 set of pixels has gone through DCT and then quantized. The result is the following matrix: (*matrix to be provided*).

Excluding the DC coefficient (-26) and zero entries, design a Huffman code to enable the remaining 20 coefficients. Find the total number of bits needed to encode these 20 coefficients with your code. (10 marks)

- f) A viewer receives TV signals with an $\frac{E_b}{N_0}$ of 8 dB. The modulation is 8PSK and a (192,188) RS code is used.
- Calculate the packet error probability. (1 mark)
 - Find the number of packet errors per day if the rate of the MPEG encoder is 10 Mbps. (2 marks)

SECTION B: ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO

- a) State one advantage and disadvantage of using B frames. (2 marks)
- b) Assume that a TV station has 7 MHz of bandwidth and wishes to transmit two different channels HDTV each with a bit rate of 15 Mbps. Find the minimum required Signal to Noise ratio at the edge of the coverage (the farthest place the station can be viewed) if M-QAM with roll-off factor $\beta=0.1$ is used and a bit error rate of $BER \leq 10^{-3}$ is required for reception. (10 marks)
- c) The block diagram of an MPEG encoder is shown in figure 2c, (*see appendix*). Very briefly (in one or two sentences for each block) describe the system: One sentence say what function the block performs and the other explain why that function is needed. (8 marks)

QUESTION THREE

- a) A TV station transmits video with a rate of 12 Mbps. Assume that the Station wishes to have an error free transmission for half an hour.
- i. Calculate the required BER (2 marks)
- ii. Assume that the station has 6 MHz of bandwidth and uses an MPSK modulation scheme with a roll-off factor of 0.2. Determine the required $\frac{E_b}{N_0}$ (3 marks)
- iii. Calculate the required $\frac{E_b}{N_0}$ if DVB Reed Solomon code is used. (5 marks)
- iv. Assume that the carrier frequency is 521 MHz and the station would like to cover viewers having antennas with 5dBi gain and receivers with overall noise figure of 15 dB up to a distance of 50 Km. Find the station's EIRP without and with RS coding. Assume LOS propagation model. (4 marks)
- b) The uplink signal to noise ratio of a satellite link is $(\frac{E_b}{N_0})_u=12$ dB and downlink SNR is $(\frac{E_b}{N_0})_D=20$ dB. Find the overall $\frac{E_b}{N_0}$ in dB. (2 marks)
- c) An audio signal is assumed to have frequencies up to 15 kHz, it is sampled at 20% above Nyquist rate. Assume the samples are quantized such that the signal to quantization noise ratio is 73 dB. Find the bit rate of the quantized signal. (Assume the audio signal can be approximated as sinusoidal waveform.)

QUESTION FOUR

- a) A TV receiver has an antenna with noise temperature of 2900^0K , an LNA with a gain of 20 dB and noise figure of 6 dB, a cable with 3 dB loss, an amplifier with gain of 30 dB and noise figure of 15 dB and a receiver with a noise temperature of 900^0K . Find the overall noise figure of the system if:
- (i) the LNA is connected between the antenna and cable. (3 marks)
 - (ii) the LNA is connected at the end of the cable. (3 marks)
- b) The transmit antenna of a TV station has a gain of 15dBi and is installed at a height of 50 meters. The transmitter power is 50 Watts. Determine the received signal power of a viewer who is 5 km away from the TV station and whose antenna has a gain of 5 dBi and is installed at a height of 5 meters. Use two-ray propagation model. (8 marks)
- c) The received power (P_r) at a location is -85 dBm. The rate is 10 Mbps and the equivalent system noise temperature is 2600^0K
- i. Find the $\frac{E_b}{N_0}$ (2 marks)
 - ii. Find the minimum bandwidth required if MPSK is used with roll-off factor of 0.1 and BER of 10^{-5} is required. (4 marks)