21ECC302T Analog and Digital Communication

<u>**Assignment- Answer Key**</u>

Year & Sem: III & VI   **Max. Marks: 30**

Q1. The signal should be sampled at a frequency 5×2=10 kHz (Sampling theorem). Each sample is then quantized to one of the eight levels. Looking at each quantized level as a message, we get

H = - (0.25 log 0.25 + 0.2 log 0.2 + 0.2 log 0.2 + 0.1 log 0.1 + 0.1 log 0.1 + 0.05 log 0.05 + 0.05 log 0.05 + 0.05 log 0.05)
 = 2.74 bits/message   **(3 Marks)**

As the sampling frequency is 10 kHz, the message rate = 10,000 messages/s. Hence, the rate of information is

R = rH = 10,000 × 2.74 **= 27,400 bits/s.**   **(2 Marks)**

Q2.   **(2 Marks)**

The average code length L is given by:

$$L = \sum_i P_i \cdot l_i$$ **(3 Marks)**

where P_i is the probability of symbol i and l_i is the length of its code.

$$L = (0.40 \times 1) + (0.15 \times 3) + (0.15 \times 3) + (0.15 \times 3) + (0.15 \times 3)$$

$$L = 0.40 + 0.45 + 0.45 + 0.45 + 0.45 = 2.2 \text{ bits per symbol}$$ **(3 Marks)**

The entropy H of the source is:

$$H = -\sum P_i \log_2 P_i$$

$$H = -(0.40 \log_2 0.40 + 4 \times 0.15 \log_2 0.15)$$

$$H = 2.171 \text{ bits per symbol}$$

Efficiency η is given by: **(2 Marks)**

$$\eta = \frac{H}{L} \times 100 = \frac{2.171}{2.2} \times 100 \approx 98.68\%$$

Q3.

$$H = \sum_{k=1}^{6} p_k \log \frac{1}{p_k}$$ **(3 Marks)**

$$= \frac{1}{2} \log 2 + \frac{1}{4} \log 4 + \frac{1}{8} \log 8 + \frac{1}{16} \log 16 + \frac{1}{32} \log 32 + \frac{1}{32} \log 32$$

$$= \frac{31}{16} \text{ bits / message}$$
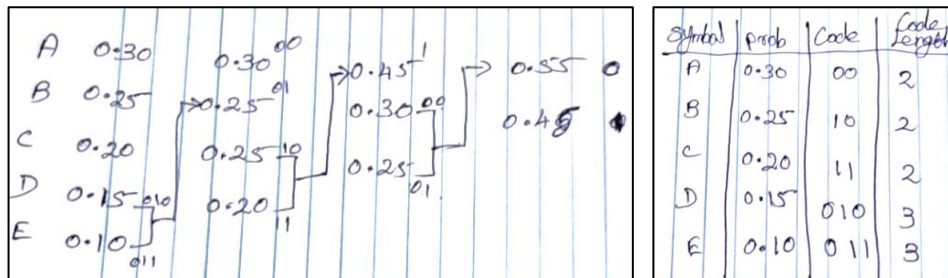
the rate of information R is **(2 Marks)**

$$R = rH$$

$$= 16 \times \frac{31}{16}$$

$$= 31 \text{ bits/s}$$

Q4. **(2 Marks)**

The average code length (L) is calculated by multiplying the length of each code by its probability and summing the results:

L = (0.30 * 2) + (0.25 * 2) + (0.20 * 2) + (0.15 * 3) + (0.10 * 3)

L = 0.60 + 0.50 + 0.40 + 0.45 + 0.30

L = 2.25 bits/symbol **(3 Marks)**

The entropy H is: **(3 Marks)**

$$H = -\sum P_i \log_2 P_i$$

$$H = -(0.30 \times (-1.737) + 0.25 \times (-2.000) +$$
$$0.20 \times (-2.322) + 0.15 \times (-2.737) + 0.10 \times (-3.322))$$
$$= 2.23 \text{ bits per symbol}$$

Efficiency η is: **(2 Marks)**

$$\eta = \frac{H}{L} \times 100 = \frac{2.23}{2.40} \times 100 \approx 92.92\%$$