THIAGARAJAR COLLEGE OF ENGINEERING

DEPARTMENT OF INFORMATION TECHNOLOGY

Worksheet- 1B

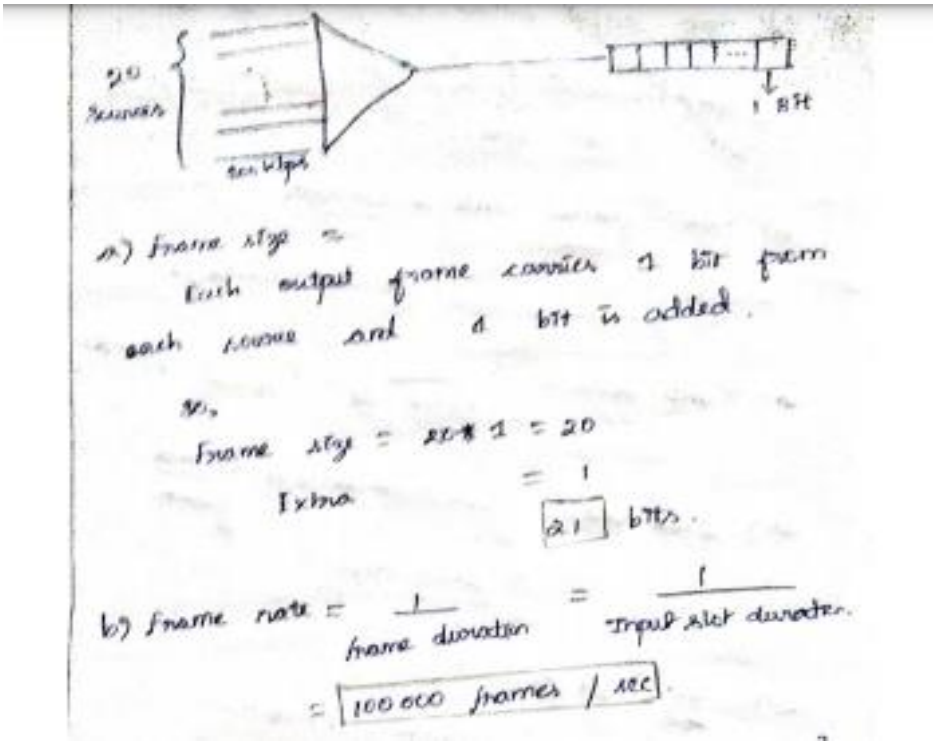
MULTIPLEXING

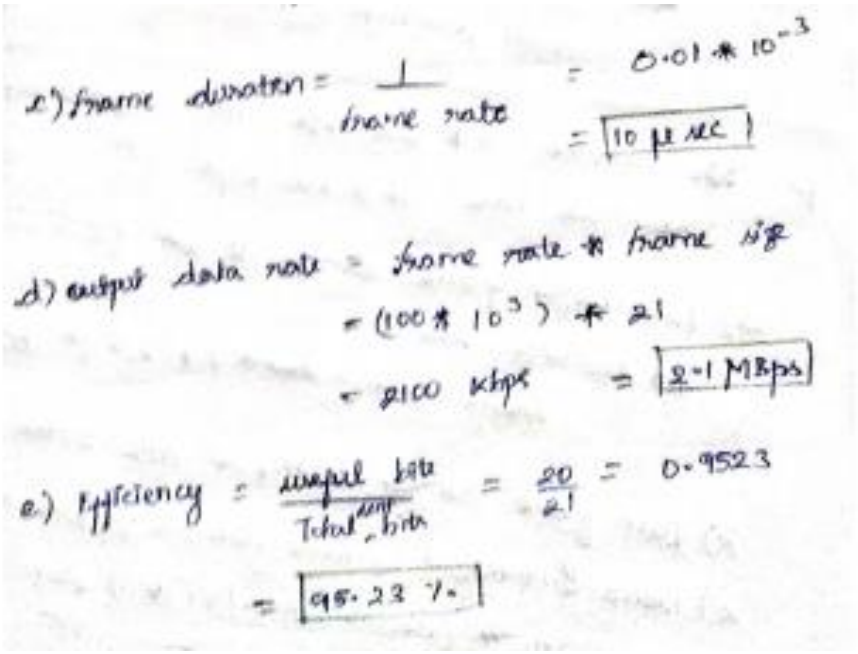
1. Assume that a voice channel occupies a bandwidth of 4 kHz. We need to multiplex 10 voice channels with guard bands of 500 Hz using FDM. Calculate the required bandwidth.

   To multiplex 10 voice channels, we need **nine guard bands**. The required bandwidth is
   = (4000 Hz) × 10 + (500 Hz) × 9
   = 40000Hz +4500Hz
   = 44500Hz

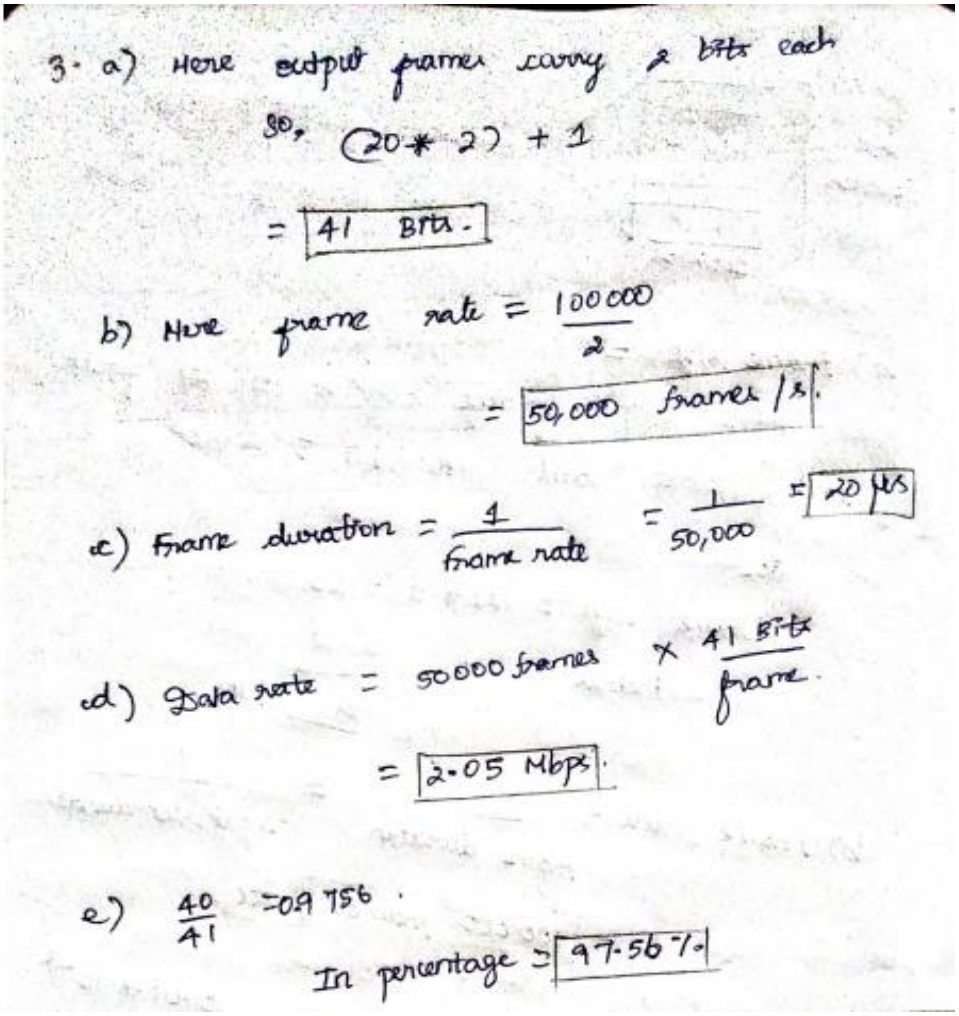
required bandwidth	= 44.5 KHz

2. We need to use synchronous TDM and combine 20 digital sources, each of 100 Kbps. Each output slot carries 1 bit from each digital source, but one extra bit is added to each frame for synchronization. Answer the following questions:
   - **a.** What is the size of an output frame in bits?
   - **b.** What is the output frame rate?
   - **c.** What is the duration of an output frame?
   - **d.** What is the output data rate?
   - **e.** What is the efficiency of the system (ratio of useful bits to the total bits)?





3. Repeat Problem 2 if each output slot carries 2 bits from each source.



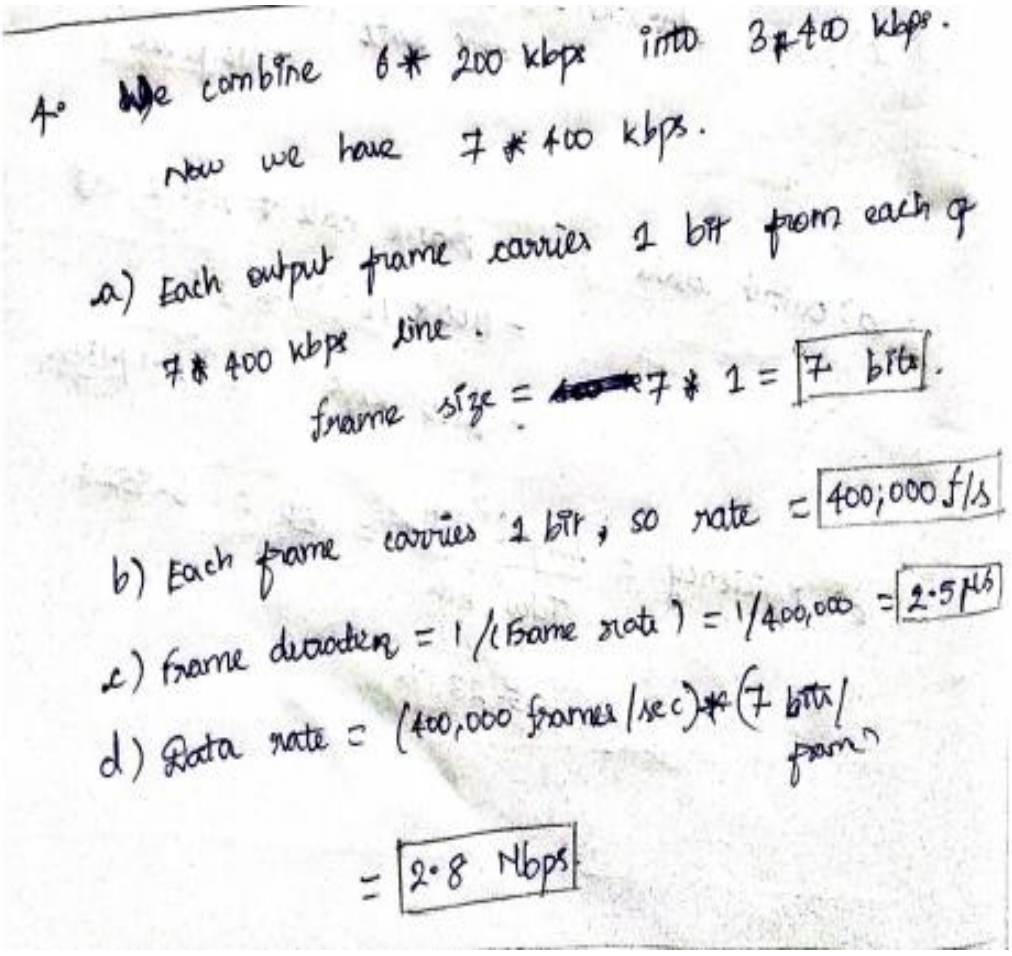
4. Ten sources, six with a bit rate of 200 kbps and four with a bit rate of 400 kbps, are to be combined using multilevel TDM with no synchronizing bits. Answer the following questions about the final stage of the multiplexing:

   a. What is the size of a frame in bits?

   b. What is the frame rate?

   c. What is the duration of a frame?

   d. What is the data rate?



5. Four channels, two with a bit rate of 200 kbps and two with a bit rate of 150 kbps, are to be multiplexed using multiple-slot TDM with no synchronizationbits. Answer the following questions:

   a. What is the size of a frame in bits?

   b. What is the frame rate?

   c. What is the duration of a frame?

   d. What is the data rate?

---

5. a) the frame carries 4 bits from each of the first 2 sources and 3 bits from each of the second two sources.

Frame size = (4 * 2) + (3 * 2)

= 14 bits.

b) Each frame carries 4 bit from 200 Kbps source or 3 bits from each 150 Kbps source.

Frame rate = $\frac{20000}{4}$ = 50,000 frames/s

c) Frame duration = $\frac{1}{\text{frame rate}}$ = $\frac{1}{50000}$ = 20 μs

d) output data rate = (50,000 f/s) * (14 bits/frame)

= 700 kbps.

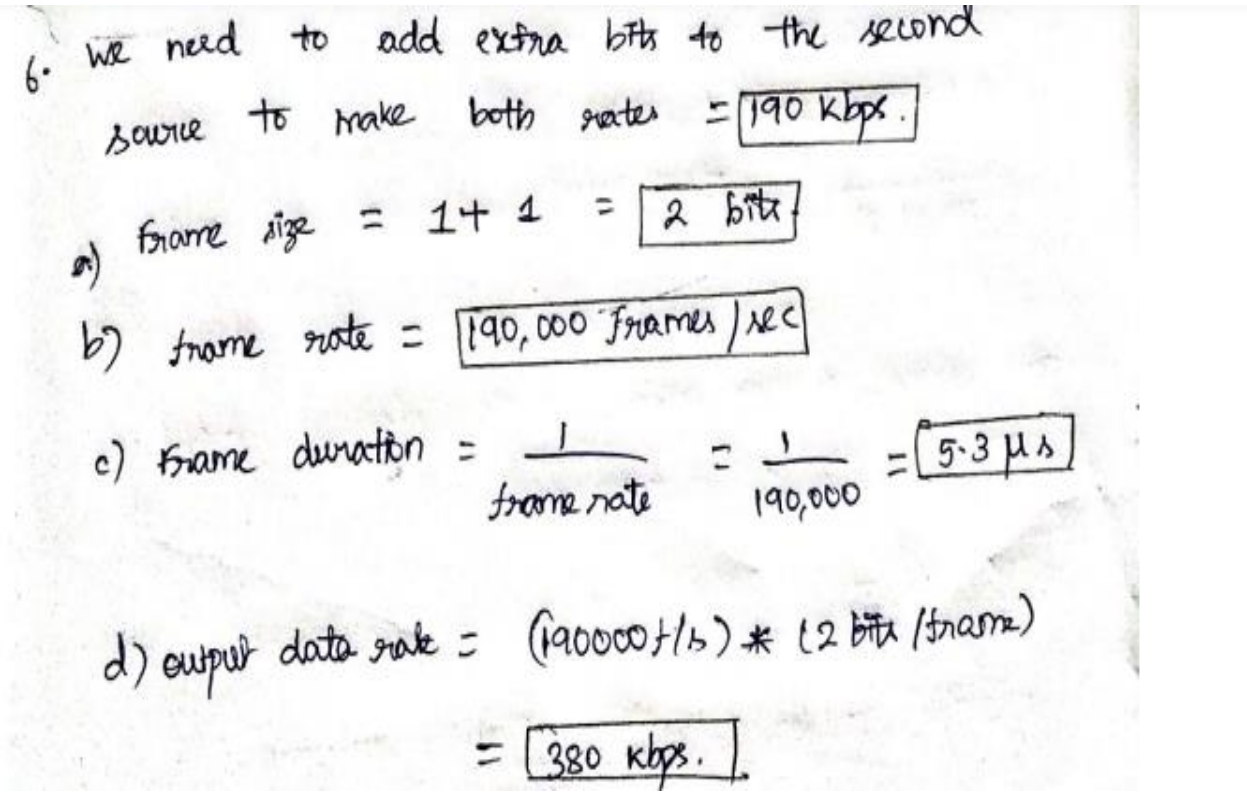
6. Two channels, one with a bit rate of 190 kbps and another with a bit rate of 180 kbps, are to be multiplexed using pulse-stuffing TDM with no synchronization bits. Answer the following questions:

   a. What is the size of a frame in bits?

   b. What is the frame rate?

   c. What is the duration of a frame?

   d. What is the data rate?



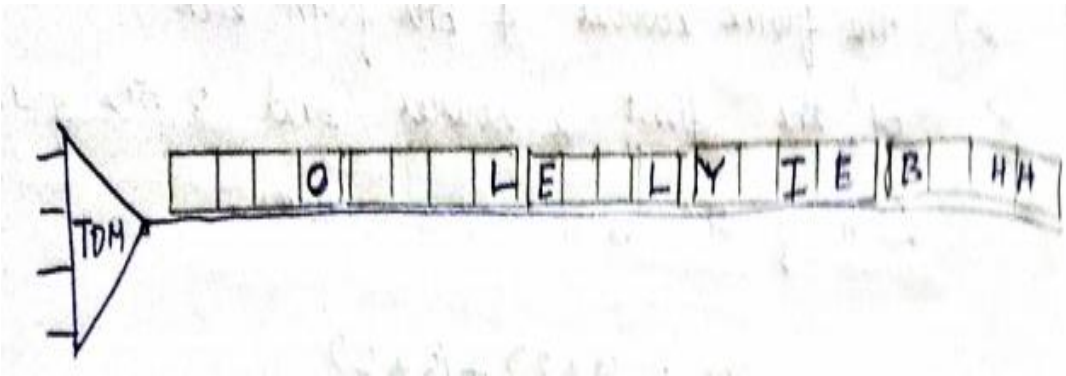
7. Show the contents of the five output frames for a synchronous TDM multiplexer that combines four sources sending the following characters. Note that the characters are sent in the same order that they are typed. The third source is silent.

   a. Source 1 message: HELLO

   b. Source 2 message: HI

   c. Source 3 message:

   d. Source 4 message: BYE



8. Figure 6.35 shows a demultiplexer in a synchronous TDM. If the input slot is 16 bits long (no framing bits), what is the bit stream in each output? The bits arrive at the demultiplexer as shown by the arrows.