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CMR INSTITUTE OF TECHNOLOGY, BENGALURU. ACCREDITED WITH A+ GRADE BY NAAC

Internal Assessment Test 2 – October. 2019

Sub:	Multimedia Communication					Sub Code:	15EC741	Branch:	ECE
Date:	14/10/2019	Duration:	90 min's	Max Marks:	50	Sem / Sec:	VII A,B,C & D		OBE

Answer any FIVE FULL Questions

	MARKS	CO	RBT
1. Explain the principle of operation of PCM speech codec with a block diagram. Also explain compressor and expander characteristics.	[10]	CO4	L1
2. (a) Explain different types of texts in detail.	[06]	CO1	L1
(b) Assuming the bandwidth of a speech signal is from 50 Hz through to 10 kHz and that of a music signal is from 15 Hz through to 20kHz, derive the bit rate that is generated by the digitization procedure in each case assuming the Nyquist sampling rate is used with 12 bits per sample for the speech signal and 16 bits per sample for the music signal. Derive the memory required to store a 10 minute passage of stereophonic music.	[04]	CO4	L3
3. (a) Explain Interlaced scanning principle with a diagram.	[05]	CO1	L1
(b) Derive the bit rate and the memory requirements to store each frame that results from the digitization of both a 525 line and 625 line systems, assuming a 4:2:2 format. Also find the total memory required to store a 1.5 hour movie/video.	[05]	CO4	L3
4. Explain briefly about the principles of Compression.	[10]	CO5	L1
5. Messages Comprising seven different characters, A through G, are to be transferred over a data link. Analysis has shown that the relative frequency of occurrence of each character is: A = 0.10, B= 0.25, C = 0.05, D = 0.32, E = 0.01, F = 0.07, G= 0.2 (i)Derive the entropy of the messages (ii) Use static Huffman coding to derive a suitable set of codewords. (iii)Derive the average number of bits per codeword for your codeword set	[10]	CO5	L3
6. A message comprising of a string of characters with probabilities e=0.3, n=0.3, t=0.2, w=0.1, . =0.1 is to be encoded. The message is "went". Compute the Arithmetic code word.	[10]	CO5	L3

CMR INSTITUTE OF TECHNOLOGY
DEPARTMENT OF ECE
SCHEME & SOLUTION –IAT 2-OCT 2019
Multimedia Communication-15EC741

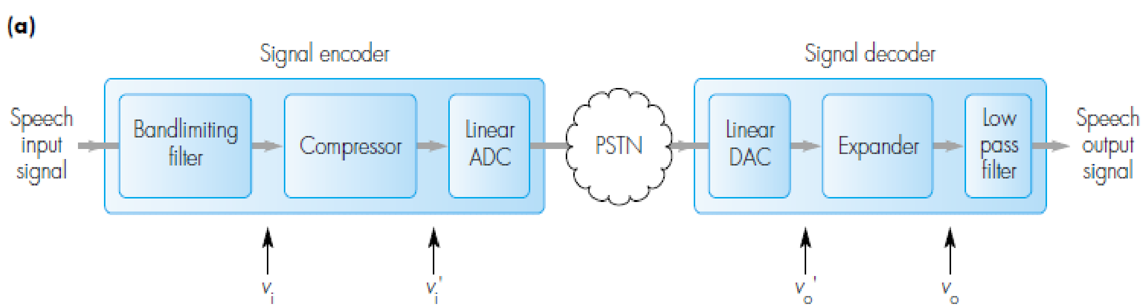
1. 1. PCM Speech CODEC (Diagram-5 M(Block diagram-3 M, Compressor Charcteristics-1 M, Expander Characteristics- 1M,Explanation-5 M)

   It is a digitization process. Defined in ITU-T Recommendations G.711. PCM consists of encoder and decoder. It consists of expander and compressor. As compared to earlier where linear quantization is used – noise level same for both loud and low signals.

   AS ear is more sensitive to noise on quite signals than loud signals, PCM system consists of non-linear quantization with narrow intervals through compressor. At the destination expander is used. The overall operation is companding. Before sampling and using ADC, signal passed through compressor first and passed to ADC and quantized.

   At the receiver, codeword is first passed to DAC and expander.

   Two compressor characteristics – A law and μ law.



(b)

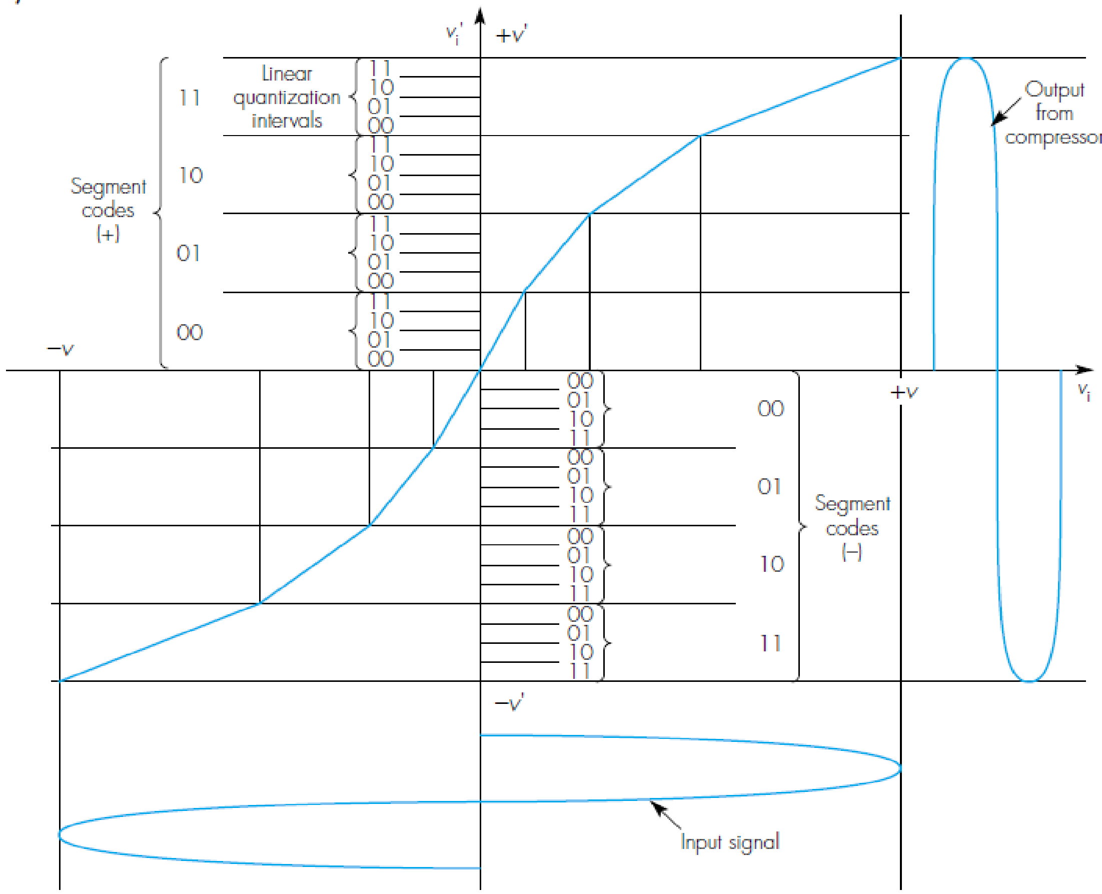
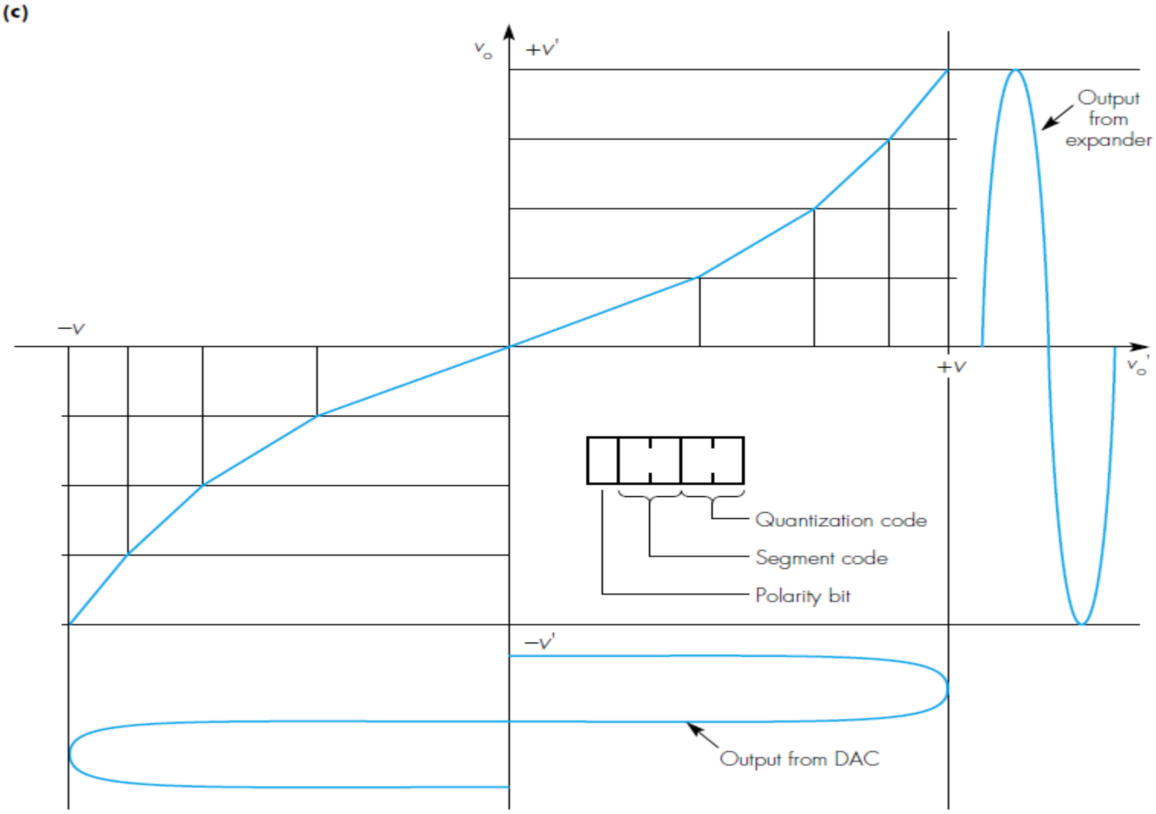


Fig: Compressor Characteristics

(c)



Note that in the G.711 standard a 3-bit segment code and 4-bit quantization code are used.

Fig: Expander Characteristics

2. (a) Different types of Text:

- *Unformatted text*: Known as plain text; enables pages to be created which comprise strings of fixed-sized characters from a limited character set
- *Formatted Text*: Known as rich text; enables pages to be created which comprise of strings of characters of different styles, sizes and shape with tables, graphics, and images inserted at appropriate points
- *Hypertext*: Enables an integrated set of documents (Each comprising formatted text) to be created which have defined linkages between them
- **Unformatted Text – The basic ASCII character set**

Bit positions			7	0	0	0	0	1	1	1	1
			6	0	0	1	1	0	0	1	1
			5	0	1	0	1	0	1	0	1
4	3	2	1								
0	0	0	0	NUL	DLE	SP	0	@	P	\	p
0	0	0	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	STX	DC2	"	2	B	R	b	r
0	0	1	1	ETX	DC3	#	3	C	S	c	s
0	1	0	0	EOT	DC4	$	4	D	T	d	t
0	1	0	1	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	ACK	SYN	&	6	F	V	f	v
0	1	1	1	BEL	ETB	'	7	G	W	g	w
1	0	0	0	BS	CAN	(	8	H	X	h	x
1	0	0	1	HT	EM	)	9	I	Y	i	y
1	0	1	0	LF	SUB	*	:	J	Z	j	z
1	0	1	1	VT	ESC	+	;	K	[	k	{
1	1	0	0	FF	FS	,	<	L	\	l	|
1	1	0	1	CR	GS	–	=	M	]	m	}
1	1	1	0	SO	RS	.	>	N	^	n	~
1	1	1	1	SI	US	/	?	O	—	o	DEL

- Control characters

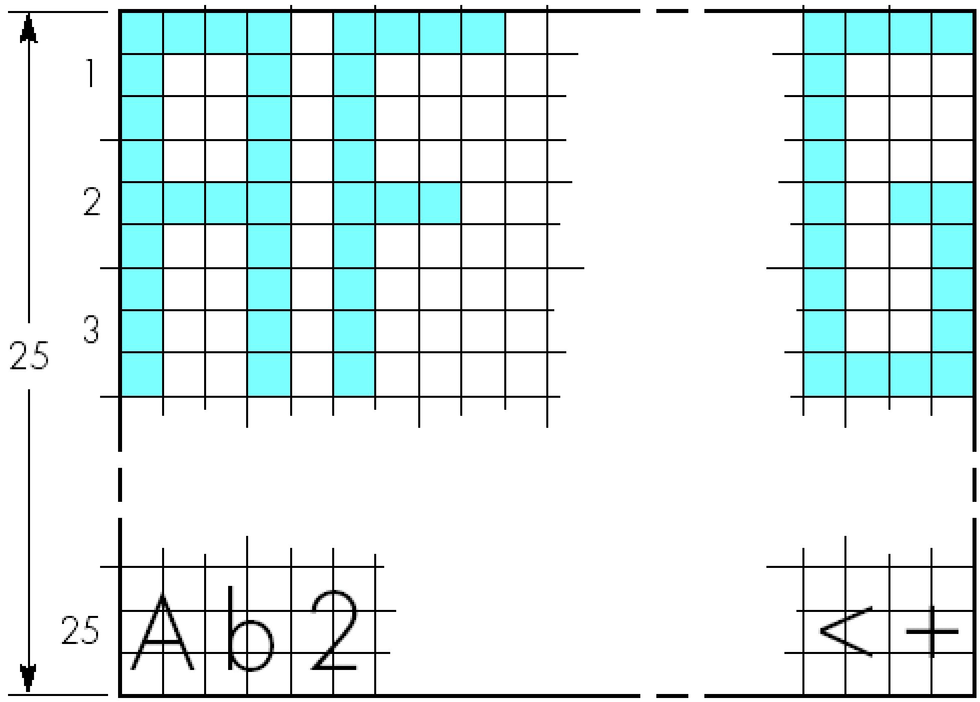
  (Back space, escape, delete, form feed etc)

- Printable characters

  (Alphabetic, numeric, and punctuation)

  The American Standard Code for Information Interchange is one of the most widely used character sets and the table includes the binary *codewords* used to represent each character (7 bit binary code)

- Although in practice the total page is made up of a matrix of symbols and characters which all have the same size, some simple graphical symbols and text of larger sizes can be constructed by the use of groups of the basic symbols



Note: Grid only included as a template.

- **Formatted Text**
- It is produced by most word processing packages and used extensively in the publishing sector for the preparation of papers, books, magazines, journals and so on..
- Documents of mixed type (characters, different styles, fonts, shape etc) possible.
- Format control characters are used

```
<B><FONT SIZE=4><P>Formatted Text</P>
</B></FONT>
<P>This is an example of formatted text, it includes:</P>
<FONT SIZE=2>
</FONT><I><P>Italics,</I> <B>Bold</B> and <U>Underlining</P>
</U>
<FONT FACE="French Script MT"><P>Different Fonts</FONT> and <FONT
SIZE=4>Font Sizes</P>
```

Formatted text

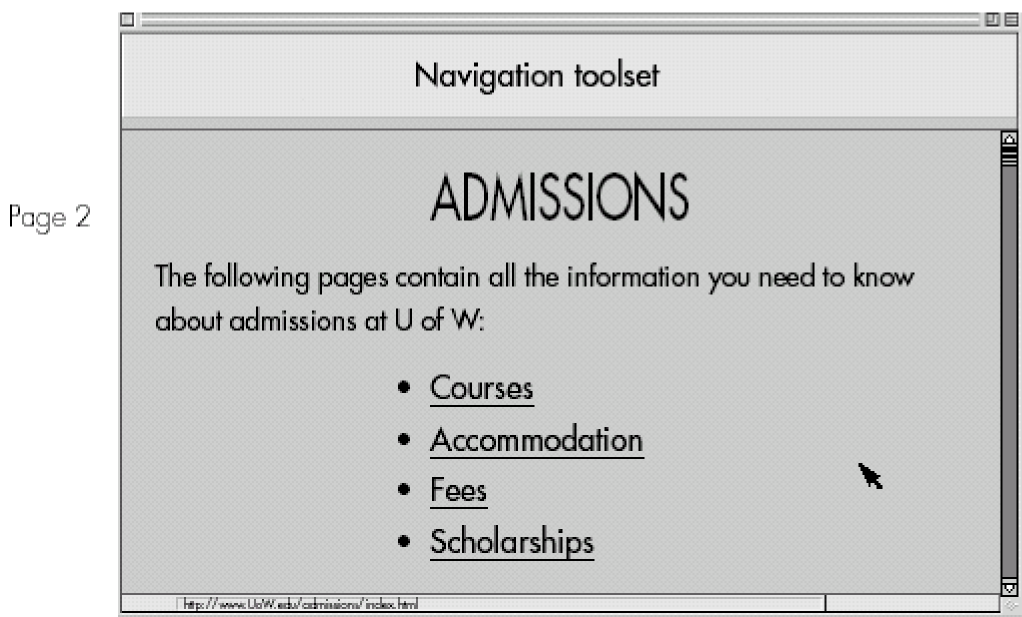
This is an example of formatted text, it includes:

Italics, **Bold** and Underlining

Different Fonts and Font Sizes

Hypertext – Electronic Document in hypertext

- Hypertext can be used to create an electronic version of documents with the index, descriptions of departments, courses on offer, library, and other facilities all written in hypertext as pages with various defined hyperlinks



Note:
- Page 2 is displayed after clicking the cursor on •Admissions of Page 1
- Selected images can be used as a background.
- Hyperlinks can be either underlined (as shown) or in a different color

An example of a hypertext language is HTML used to describe how the contents of a document are presented on a printer or a display; other mark-up languages are: Postscript, SGML (Standard Generalized Mark-up language) Tex, Latex.

2. (b)

Assuming the bandwidth of a speech signal is from 50 Hz through to 10 kHz and that of a music signal is from 15 Hz through to 20 kHz, derive the bit rate that is generated by the digitization procedure in each case assuming the Nyquist sampling rate is used with 12 bits per sample for the speech signal and 16 bits per sample for the music signal. Derive the memory required to store a 10 minute passage of stereophonic music.

Answer:

(i) Bit rates: Nyquist sampling rate = $2 f_{max}$

Speech: Nyquist rate = 2×10 kHz = 20 kHz or 20 ksps
Hence with 12 bits per sample, bit rate generated = $20\text{k} \times 12 = 240$ kbps

Music: Nyquist rate = 2×20 kHz = 40 kHz or 40 ksps
Hence bit rate generated = $40\text{k} \times 16 = 640$ kbps (mono)
or $2 \times 640\text{k} = 1280$ kbps (stereo)

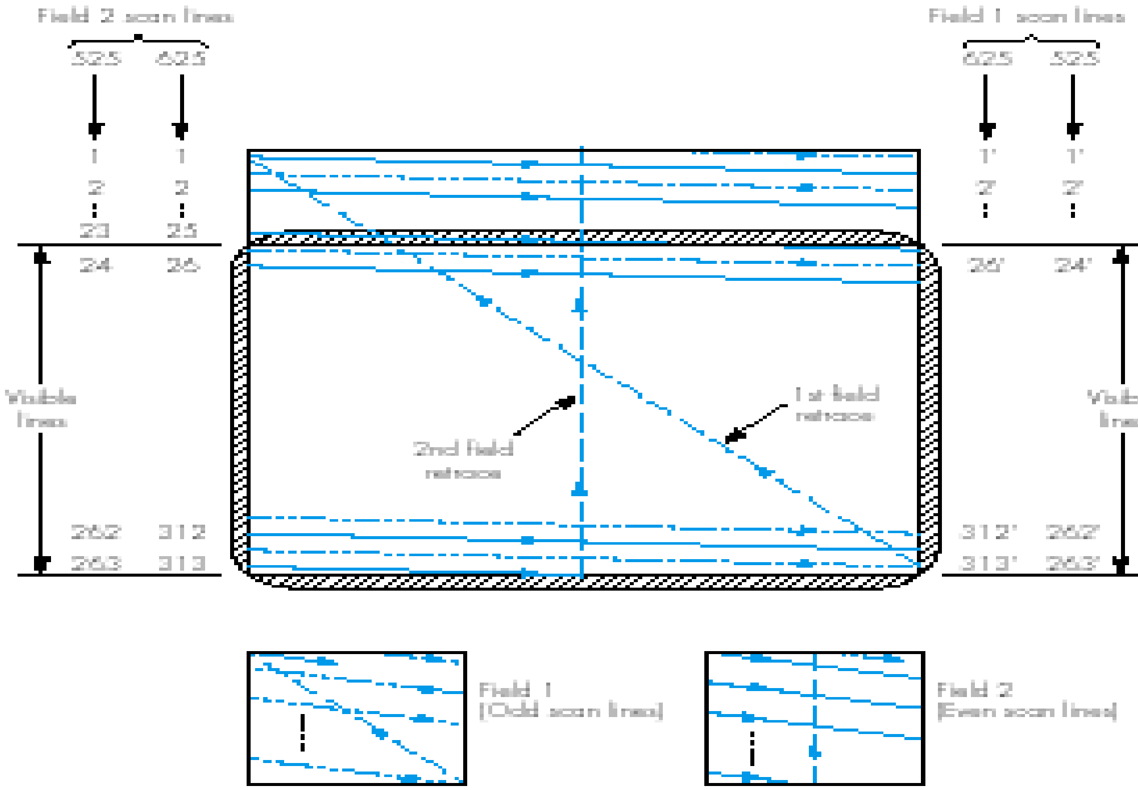
(ii) Memory required: Memory required = bit rate (bps) × time (s)/8 bytes
Hence at 1280 kbps and 600 s,

$$\text{Memory required} = \frac{1280 \times 10^3 \times 600}{8} = 96 \text{ Mbytes}$$

3. (a) Interlaced Scanning

- It is necessary to use a minimum refresh rate of 50 times per second to avoid flicker
- A refresh rate of 25 times per second is sufficient
- Field:the first comprising only the odd scan lines and the second the even scan lines
- The two field are then integrated together in the television receiver using a technique known as interlaced scanning
- The three main properties of a color source
    - Brightness
    - Hue:this represents the actual color of the source
    - Saturation:this represents the strength or vividness of the color
    - The term luminance is used to refer to the brightness of a source
    - The hue and saturation are referred to as its chrominance
    - Where Ys is the amplitude of the luminance signal and Rs,Gs and Bs are the magnitudes of the three color component signals
    - The blue chrominance (Cb), and the red chrominance (Cr) are then used to represent hue and saturation
    - The two color difference signals:
    - $C_b = B_s - Y_s$ $\qquad$ $C_r = R_s - Y_s$

Figure 2.19 Interlaced scanning principles.



525-line systems: 262.5 each field, 240 visible
625-line systems: 312.5 each field, 288 visible

3. (b)

Derive the bit rate and the memory requirements to store each frame that result from the digitization of both a 525-line and a 625-line system assuming a 4:2:2 format. Also find the total memory required to store a 1.5 hour movie/video.

Answer:

525-line system: The number of samples per line is 720 and the number of visible lines is 480. Hence the resolution of the luminance (Y) and two chrominance (C_b and C_r) signals are:

$$Y = 720 \times 480$$
$$C_b = C_r = 360 \times 480$$

Bit rate: Line sampling rate is fixed at 13.5 MHz for Y and 6.75 MHz for both C_b and C_r, all with 8 bits per sample.

Hence: Bit rate $= 13.5 \times 10^6 \times 8 + 2\ (6.75 \times 10^6 \times 8) = 216$ Mbps

Memory required: Memory required per line $= 720 \times 8 + 2\ (360 \times 8)$
$= 11\,520$ bits or 1440 bytes

Hence memory per frame, each of 480 lines $= 480 \times 11\,520$
$= 5.5296$ Mbits or 691.2 kbytes

and memory to store 1.5 hours assuming 60 frames per second:
$= 691.2 \times 60 \times 1.5 \times 3600$ kbytes
$= 223.9488$ Gbytes

625-line system: Resolution: $Y = 720 \times 576$
$C_b = C_r = 360 \times 576$

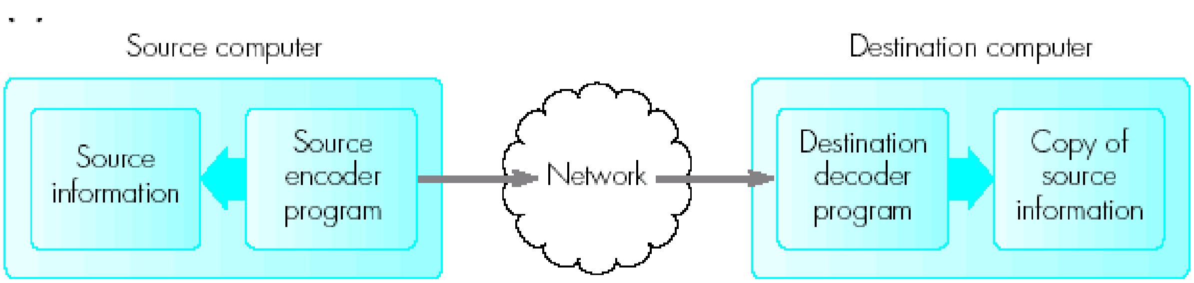
Bit rate $= 13.5 \times 10^6 \times 8 + 2\ (6.75 \times 10^6 \times 8) = 216$ Mbps

Memory per frame $= 576 \times 11\,520 = 6.635\,55$ Mbits or 829.44 kbytes

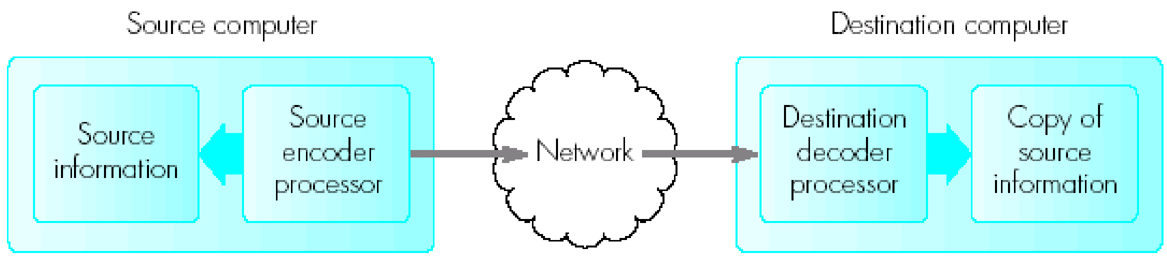
and memory to store 1.5 hours assuming 50 frames per second:
$= 829.44 \times 50 \times 1.5 \times 3600$ kbytes
$= 223.9488$ Gbytes

It should be noted that, in practice, the bit rate figures are less than the computed values since they include samples during the retrace times when the beam is switched off. Nevertheless, as we can deduce from the computed values, both the bit rate and the memory requirements are very large for both systems and it is for this reason that the various lower resolution formats have been defined.

4. Principles of Compression



- By compression the volume of information to be transmitted can be reduced. At the same time a reduced bandwidth can be used
- The application of the *compression* algorithm is the main function carried out by the *encoder* and the *decompression* algorithm is carried out by the destination *decoder*



- Compressions algorithms can be classified as being either ***lossless*** (to reduce the amount of source information to be transmitted with no loss of information) – e.g transfer of text file over the network or
- ***lossy*** (reproduced a version perceived by the recipient as a true copy) – e.g digitized images, audio and video streams

Entropy Encoding:

(i)Run-Length Encoding

- Examples of run-length encoding are when the source information comprises *long substrings* of the same character or binary digit
- In this the source string is transmitted as a different set of codewords which indicates only the character but also the number of bits in the substring
- providing the destination knows the set of codewords being used, it simply interprets each codeword received and outputs the appropriate number of characters/bits

e.g. output from a scanner in a Fax Machine

000000011111111110000011 will be represented as 0,7 1,10 0,5 1,2

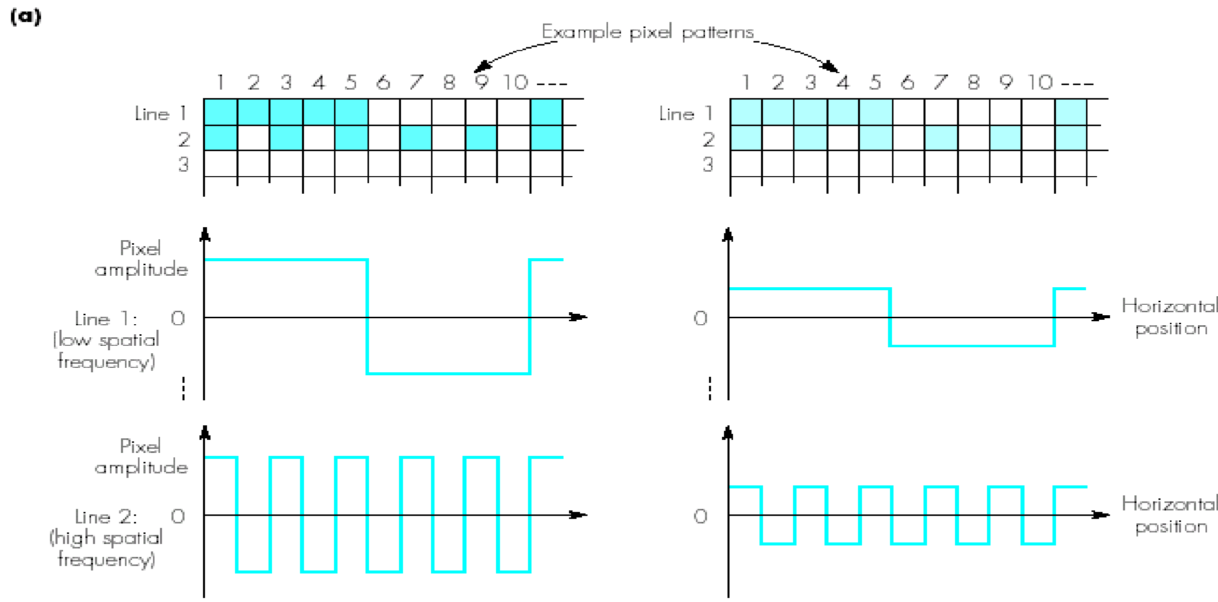
(ii) Statistical Encoding:

- A set of ASCII codewords are often used for the transmission of strings of characters
- However, the symbols and hence the codewords in the source information does not occur with the same frequency. *E.g* ***A*** may occur more frequently than ***P*** which may occur more frequently than **Q**
- The *statistical coding* uses this property by using a set of variable length codewords – the shortest being the one representing the most frequently appearing symbol

Differential Encoding

- Uses smaller codewords to represent the difference signals. Can be lossy or lossless
- This type of coding is used where the amplitude of a signal covers a large range but the difference between successive values is small
- Instead of using large codewords a set of smaller code words representing only the difference in amplitude is used
- For example if the digitization of the analog signal requires 12 bits and the difference signal only requires 3 bits then there is a saving of 75% on transmission bandwidth

Transform Coding:



- **Transform encoding** involves transforming the source information from *one form into another*, the other form lending itself more readily to the application of compression. As we scan across a set of pixel locations the rate of change in magnitude will vary from zero if all the pixel values remain the same to a low rate of change if say one half is different from the next half, through to a high rate of change if each pixel changes magnitude from one location to the next
- The rate of change in magnitude as one traverses the matrix gives rise to a term known as the '***spatial frequency***'
- Hence by identifying and eliminating the higher frequency components the volume of the information transmitted can be reduced

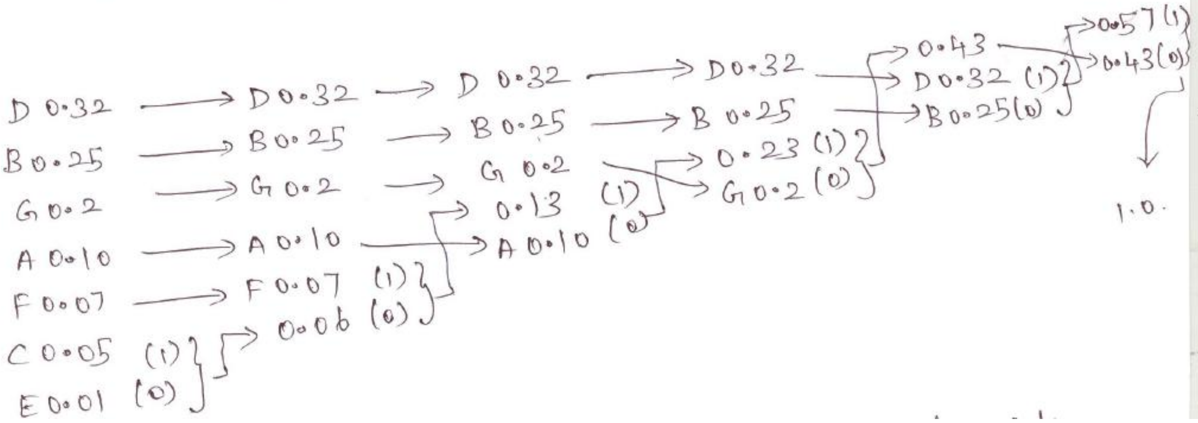
5. **Static Huffman Encoding Problem**

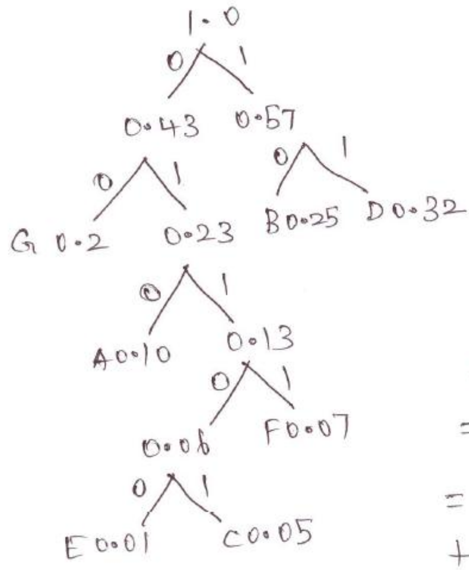
$$\text{Entropy } H = -\sum_{i=1}^{n} P_i \log_2 P_i$$

$$= -[0.10 \log_2 0.10 + 0.25 \log_2 0.25 + 0.05 \log_2 0.05 + 0.32 \log_2 0.32 + 0.01 \log_2 0.01 + 0.07 \log_2 0.07 + 0.2 \log_2 0.2]$$

$$= -3.32[-0.1 - 0.15 - 0.065 - 0.158 - 0.002 - 0.080 - 0.139]$$

$$= -3.32[-0.712] = 2.36$$





Codewords

A → 010

B → 10

C → 01101

D → 11

E → 01100

F → 0111

G → 00

Average no. of bits per codeword

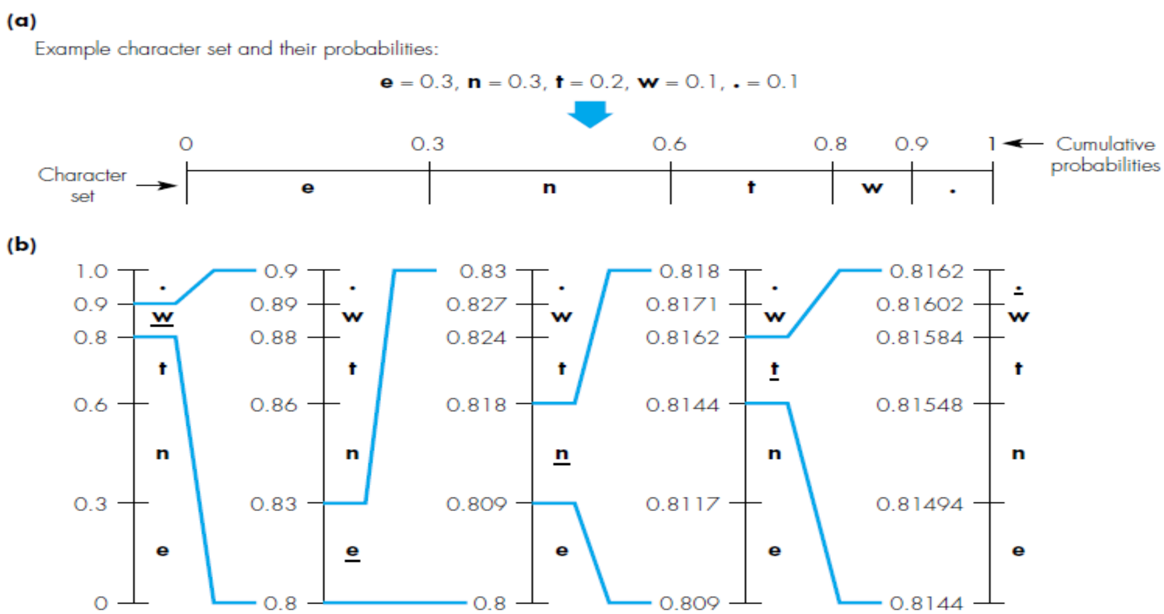
$$= \sum_{i=1}^{n} N_i P_i$$

$$= 3(0.10) + 2(0.25) + 5(0.05) + 2(0.32) + 5(0.01) + 4(0.07) + 2(0.2)$$

$$= 0.3 + 0.5 + 0.25 + 0.64 + 0.05 + 0.28 + 0.4$$

$$= 2.42$$

6. Arithmetic Coding



Encoded version of the character string **went.** is a single codeword in the range 0.816 02 ≤ codeword < 0.8162