Module 2 Notes for

# "Multimedia Communication"

# [BCE613A]

**Prepared by:**

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# AKSHAYA INSTITUTE OF TECHNOLOGY

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## DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

## VISION

To produce competent engineering professionals in the field of Electronics and Communication Engineering by imparting value based quality technical education to meet the societal needs and to develop socially responsible citizens.

## MISSION

**M1:** To provide strong fundamentals and technical skills in the field of Electronics and Communication Engineering through effective teaching learning process.

**M2:** Enhancing employability of the students by providing skills in the fields of VLSI, Embedded systems, Signal processing, etc., through Centre of Excellence.

**M3:** Encourage the students to participate in co-curricular and extra-curricular activities that creates a spirit of social responsibility and leadership qualities.

## Program Specific Outcomes (PSOs)

*After Successful Completion of Electronics and Communication Engineering Program Students will be able to*

1. Apply fundamental knowledge of core. Electronics and Communication Engineering in the analysis, design and development of Electronics Systems as well as to interpret and synthesize experimental data leading to valid conclusions.
2. Exhibit the skills gathered to analyze, design, develop software applications and hardware products in the field of embedded systems and allied areas.

## Program Educational Objectives (PEOs)

**PEO1:** Graduates exhibit their innovative ideas and management skills to meet the day to day technical challenges.

**PEO2:** Graduates utilize their knowledge and skills for the development of optimal solutions to the problems in the field of Electronics and Communication Engineering..

**PEO3:** Graduates exhibit good interpersonal skills, leadership qualities and adapt themselves for life-long Learning

| | Multimedia Communication | | Semester | 6 |
|---|---|---|---|---|
| | CourseCode | **BCE613A** | CIEMarks | 50 |
| | TeachingHours/Week(L:T:P:S) | 3:0:0 | SEEMarks | 50 |
| | TotalHoursofPedagogy | 40 | TotalMarks | 100 |
| | Credits | 03 | ExamHours | |
| | Examinationtype(SEE) | Theory | | |

**Courseobjectives:**

- Gainfundamentalknowledgeinunderstandingthebasicsofdifferentmultimedia Networks and applications.
- Understanddigitizationprincipletechniquesrequiredtoanalyzedifferentmedia Types.
- Analyzecompressiontechniquesrequiredtocompresstextandimageandgain Knowledge of DMS.
- Analyzecompressiontechniquesrequiredtocompressaudioandvideo.
- Gainfundamentalknowledgeaboutmultimediacommunicationacrossdifferent Networks.

**Teaching-LearningProcess(GeneralInstructions)**

ThesearesampleStrategies,whichteacherscanusetoacceleratetheattainmentofthevariouscourseoutcomes.

1. Lecturemethod(L)doesnotmeanonlythetraditionallecturemethod,butadifferenttypeofteachin gmethodmaybeadoptedtodeveloptheoutcomes.
2. ShowVideo/animationfilmstoexplainthefunctioningofvarioustechniques.
3. Encouragecollaborative(Group)Learningintheclass.
4. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking
5. Topicswillbeintroducedinmultiplerepresentations.
6. Discusshoweveryconceptcanbeappliedtotherealworld-andwhenthat'spossible,ithelpsimprove the students' understanding.

**Module-1**

**MultimediaCommunications:Introduction**,Multimediainformationrepresentation,Multimedianetworks,multimediaapplications,Applicationandnetworkingterminology.
(Chapter1ofText1)

**Module-2**

**InformationRepresentation**:Introduction,Digitizationprinciples,Text,Images,AudioandVideo.(Chapter 2ofText1

**Module-3**

**TextandImageCompression**:Introduction,Compressionprinciples,textcompression,imageCompression.
(Chapter 3 of Text 1 )

**Module-4**

**Audioandvideocompression**:Introduction,Audiocompression,videocompression,videocompression principles, video compression. (Chapter 4 of Text 1)

**Module-5**

**MultimediaInformationNetworks**: Introduction, LANs, Ethernet, Token ring, Bridges, FDDI (Chapter 8.1 to8.6of Text 1).

**Courseoutcome(CourseSkillSet)**

Attheendofthecourse,thestudentwillbeableto:

1. UnderstandthebasicsofmultimediaCommunicationandapplications
2. Analyzemediatypestorepresentthemindigitalform.
3. Applythecompressiontechniquesontext,images,audioandvideo.
4. Understandmultimediainformationnetworks.

## AssessmentDetails(bothCIEandSEE)

TheweightageofContinuousInternalEvaluation(CIE)is50%andforSemesterEndExam(SEE)is50%.TheminimumpassingmarkfortheCIEis40%ofthemaximummarks(20marksoutof50)andfortheSEEminimumpassingmarkis35%ofthemaximummarks(18outof50marks).Astudentshallbedeemedtohavesatisfiedtheacademicrequirementsandearnedthecreditsallottedtoeachsubject/courseifthestudentsecuresaminimumof40%(40marksoutof100)inthesumtotaloftheCIE(ContinuousInternalEvaluation)and SEE(SemesterEndExamination)takentogether.

**ContinuousInternalEvaluation:**

- FortheAssignmentcomponentoftheCIE,thereare25marksandfortheInternalAssessmentTestcomponent,thereare25marks.
- Thefirsttestwillbeadministeredafter40-50%ofthesyllabushasbeencovered,andthesecondtestwillbeadministeredafter85-90%ofthesyllabushasbeencovered
- Anytwoassignmentmethodsmentionedinthe22OB2.4,ifanassignmentisproject-basedthenonlyoneassignmentforthecourseshallbeplanned.Theteachershouldnotconducttwoassignmentsattheendofthesemesteriftwoassignmentsareplanned.
- Forthecourse,CIEmarkswillbebasedonascaled-downsumoftwotestsandothermethodsofassessment.

**InternalAssessmentTestquestionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyaspertheoutcomedefinedforthecourse.**

**Semester-EndExamination:**

TheorySEEwillbeconductedbyUniversityasperthescheduledtimetable,withcommonquestionpapersforthecourse (**duration03hours).**

1. Thequestionpaperwillhavetenquestions.Eachquestionissetfor20marks.
2. Therewillbe2questionsfromeachmodule.Eachofthetwoquestionsunderamodule(withamaximumof3sub-questions),**shouldhaveamixoftopics**underthatmodule.
3. Thestudentshavetoanswer5fullquestions,selectingonefullquestionfromeachmodule.
4. Marksscoredshallbeproportionallyreducedto50marks

**SuggestedLearningResources:**

**Textbooks:**

MultimediaCommunications–FredHalsall,PearsonEducation,2001,ISBN-978813170994

**ReferenceBooks:**

1. Multimedia:Computing,CommunicationsandApplications-RaifSteinmetz,KlaraNahrstedt,Pearson Education, 2002, ISBN-978817758
2. FundamentalsofMultimedia–Ze-NianLi,MarkSDrew,andJiangchuanLiu.

**WeblinksandVideoLectures(e-Resources):**

- Implementationofcompressionalgorithmsusing MATLAB/anyopensourcetools(Python,Scilab,etc.)

**ActivityBasedLearning(SuggestedActivitiesinClass)/PracticalBasedlearning**

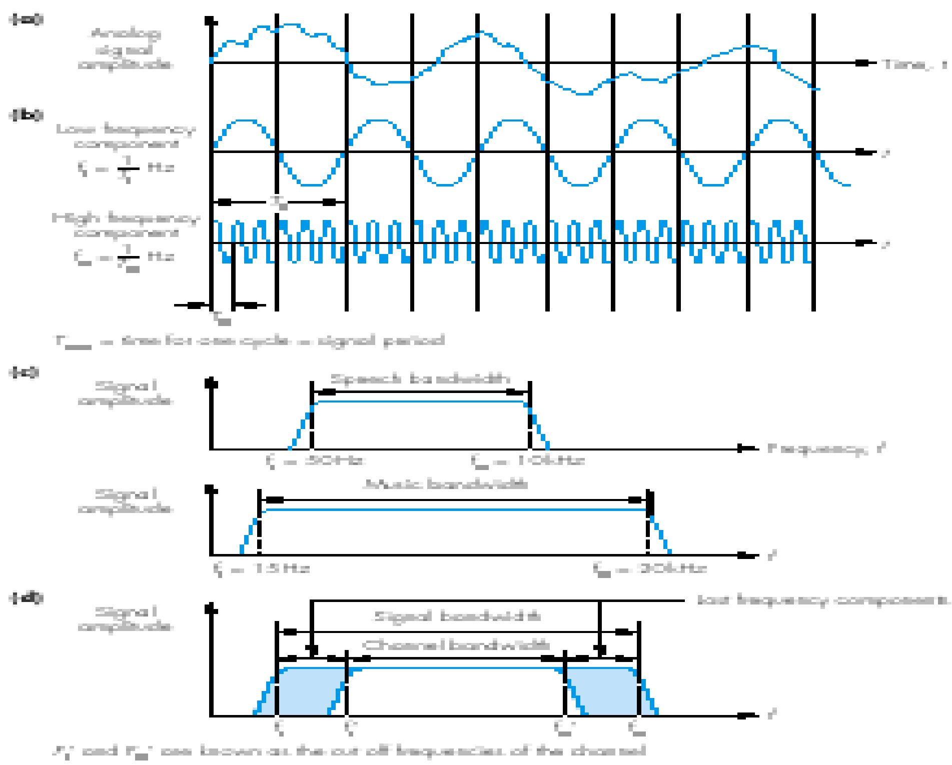
- https://www.slideshare.net
  NPTELVideoLectures
- https://archive.nptel.ac.in/courses/117/105/117105083/
- MultimediaComputinglecture:Communications&Networking–YouTube

# Module 2:Information Representation

# Introduction

- Theconversionofananalogsignalintoadigitalform
- Signalencoder,sampling, signaldecoder.
- Fourier analysis can be used to show that any time-varying analog signal is made up of a possibly infinite number of single-frequency sinusoidal signals whose amplitude and phase vary continuously with time relative to each other
- Signalbandwidth
- Fig2.1
- The bandwidth of the transmission channel should be equal to or greater than thebandwidthofthesignal—bandlimitingchannel

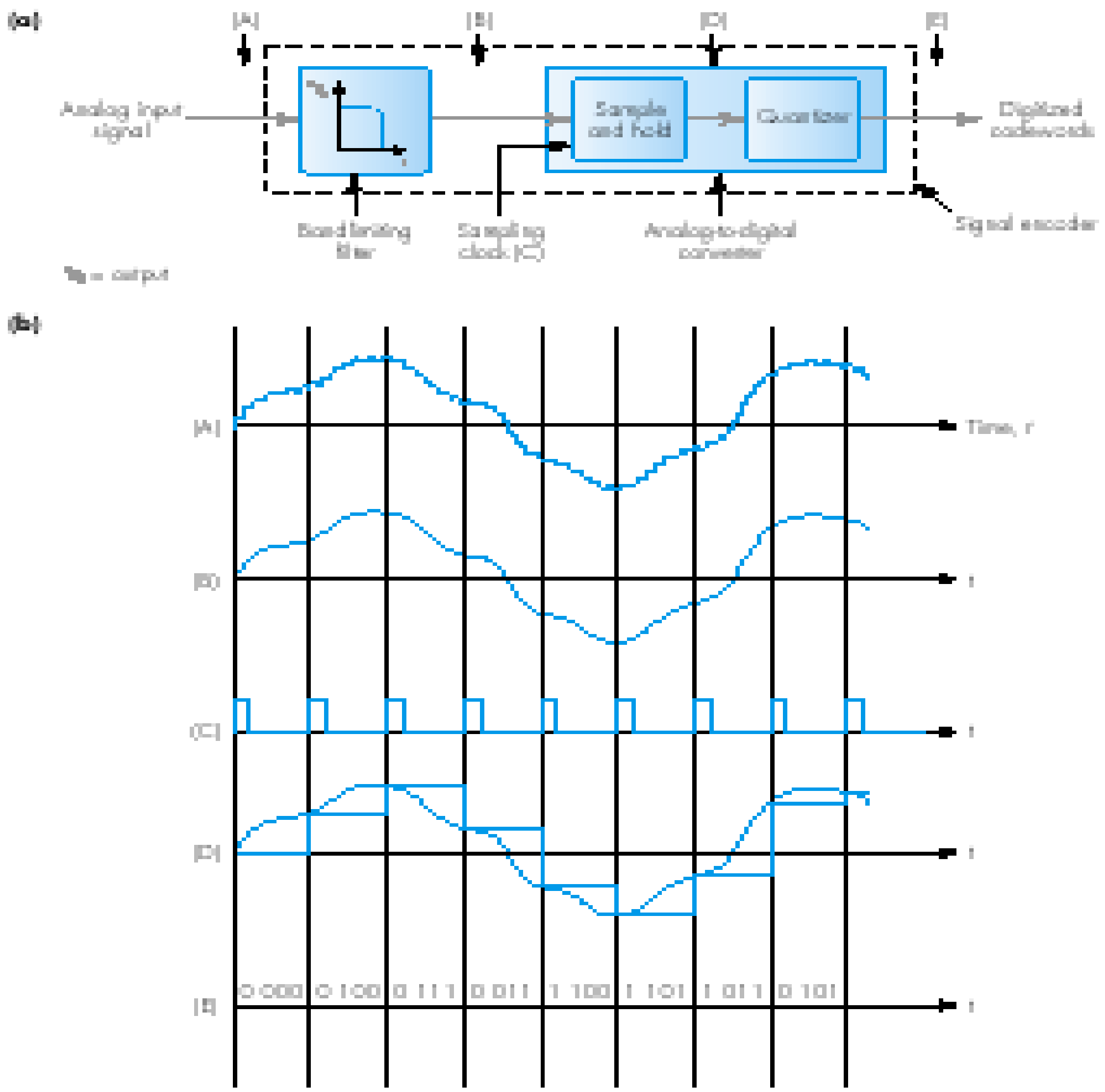
**Figure 2.1 Signal properties: (a) time-varying analog signal; (b) sinusoidial frequency components; (c) signal bandwidth examples; (d) effect of a limited bandwidth transmission channel.**



Encoderdesign

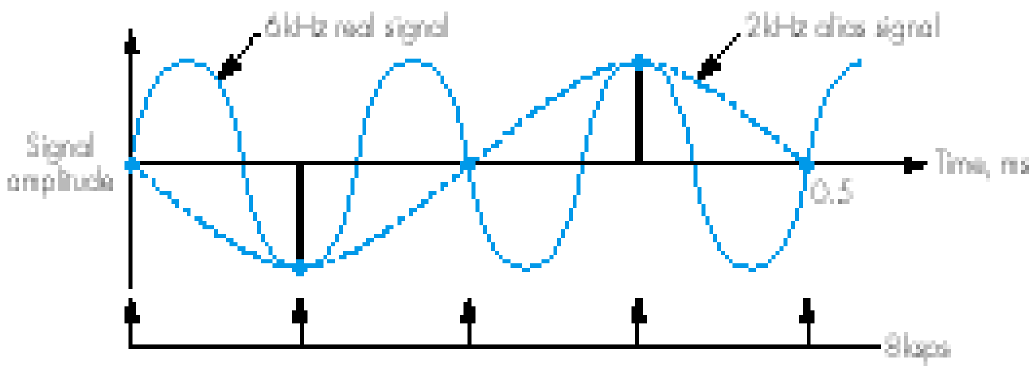
- Abandlimitingfilterandananalog-to-digitalconverter(ADC),thelattercomprising a sample-and-hold and a quantizer
- Fig2.2
- Removeselectedhigher-frequencycomponentsfromthesourcesignal(A)
- (B)isthenfedtothesample-and-holdcircuit
- Sampletheamplitudeofthefilteredsignalatregulartimeintervals(C)and holdthesample amplitudeconstant between samples(D)

**Figure 2.2 Signal encoder design: (a) circuit components; (b) associated waveform set.**



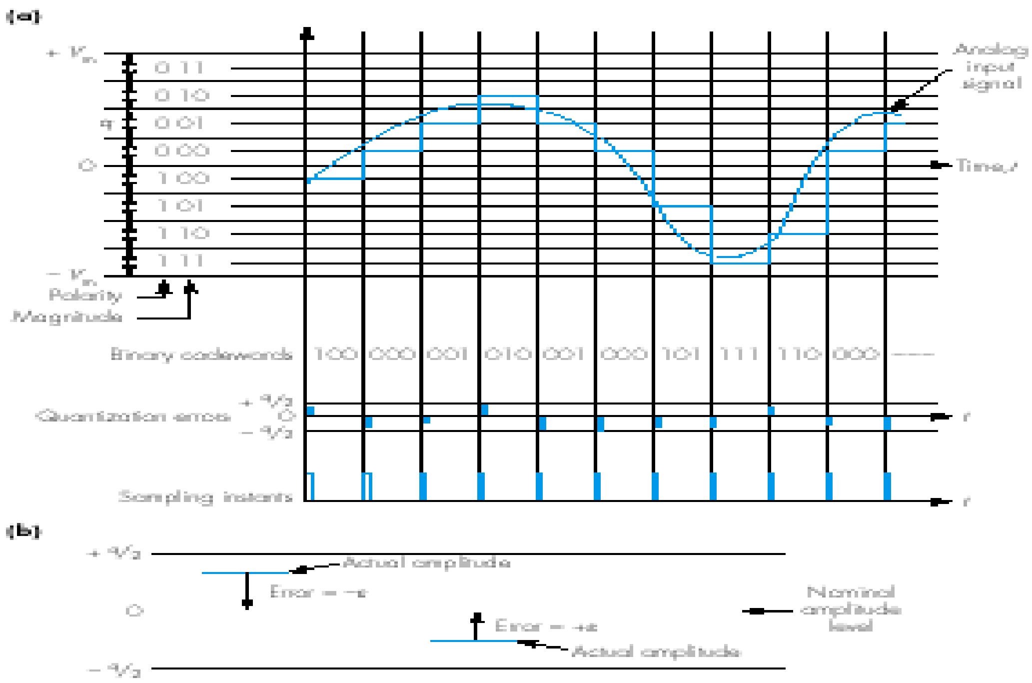
- Quantizercircuit which converts each sample amplitude into a binaryvalue known as a codeword (E)
- The signal to be sampled at a rate which is higher than the maximum rate of change of the signal amplitude
- Thenumberofdifferentquantizationlevelsusedtobeaslargeaspossible
- Nyquist sampling theorem states that: in order to obtain an accurate representationofatime-varinganalogsignal,itsamplitudemustbesampled at a minimum rate that is equal to or greater than twice the highest sinusoidal frequency component that is present in the signal
- Nyquistrate:samplespersecond(sps)
- ThedistortioncausedbysamplingasignalataratelowerthantheNyquist rate
- Fig2.3
- Aliassignals:theyreplacethecorrespondingoriginalsignals

**Figure2.3Aliassignalgenerationduetoundersampling.**




- Quantizationintervals
- A finite number of digits is used, each sample can only be represented by a corresponding number of discrete levels
- Fig2.4
- If Vmax is the maximum positive and negative signal amplitude and n is the numberofbinarybitsused,thenthemagnitudeofeachquantizationinterval, q

**Figure 2.4 Quantization procedure: (a) source of errors; (b) noise polarity.**




- Eachcodewordcorrespondstoanominalamplitudelevelwhichisatthe center of the corresponding quantization interval
- Thedifferencebetweentheactualsignalamplitudeandthecorresponding nominalamplitudeiscalledthequantizationerror(Quantizationnoise)
- Theratioofthepeakamplitudeofasignaltoitsminimumamplitudeisknown as the dynamic range of the signal, *D* (decibels or dB)

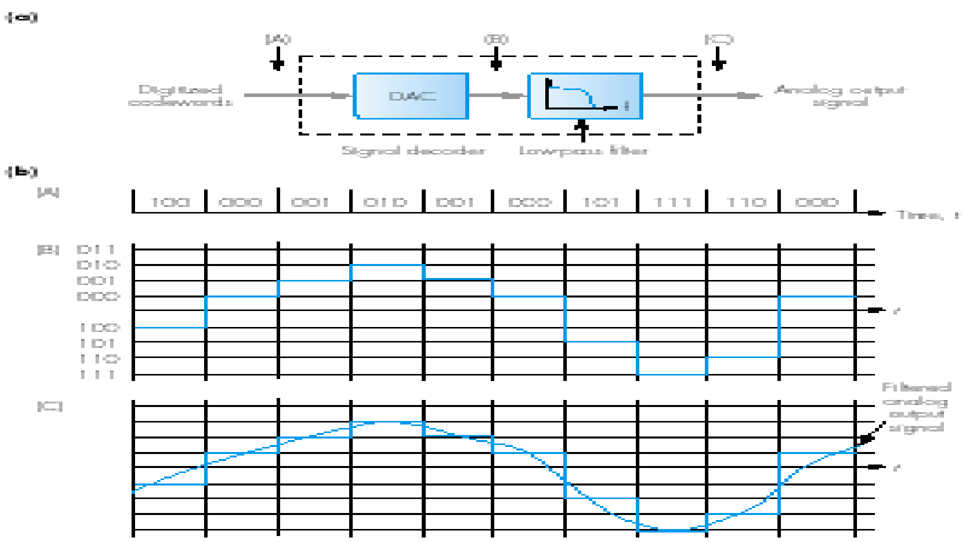
$$D=20\log_{10}\left(\frac{V_{max}}{V_{min}}\right)dB$$

- It is necessary to ensure that the level of quantization noise relative to the smallest signal amplitude is acceptable
- Example2.2

**Decoderdesign**

- Fig2.5
- Reproduce the original signal, the output of the DAC is passed through a low-pass filter which only passes those frequency components that made up the original filtered signal (C)
- Audio/videoencoder-decoderor audio/videocodec

Figure 2.5 Signal decoder design: (a) circuit components; (b) associated waveform set.



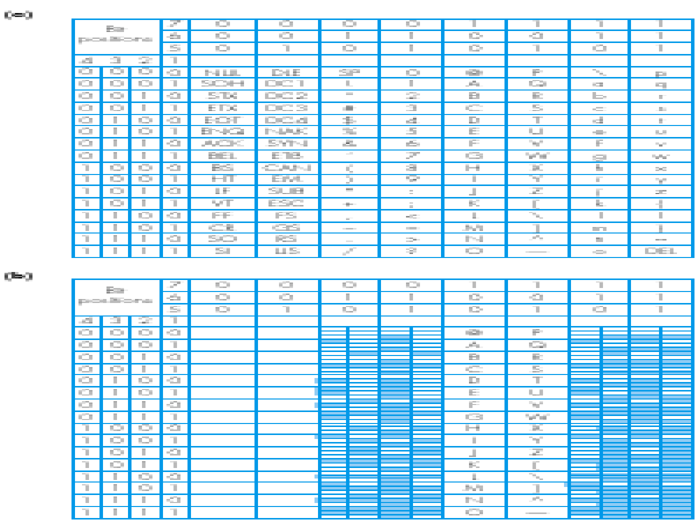

**Text**

- Threetypesoftext
  - Unformattedtext
  - Formattedtext
  - hypertext

Unformattedtext

- AmericanStandardCodeforInformationInterchange(ASCIIcharacterset)
- Fig2.6
- Mosaiccharacterscreaterelativelysimplegraphicalimages

Figure 2.6 Two example character sets to produce unformatted text: (a) the basic ASCII character set; (b) supplementary set of mosaic characters.



Formattedtext

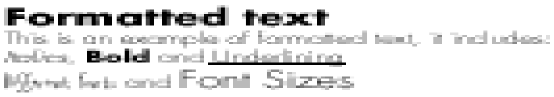
- Producedbymostwordprocessingpackages
- Each with different headings and with tables, graphics, and pictures inserted at appropriate points
- Fig2.8
- WYSIWYG:anacronymforwhat-you-see-is-what-you-get

**Figure2.8 Formatted text:(a) anexampleformattedtextstring;(b) printed version of the string.**

(a)

```
<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>
```

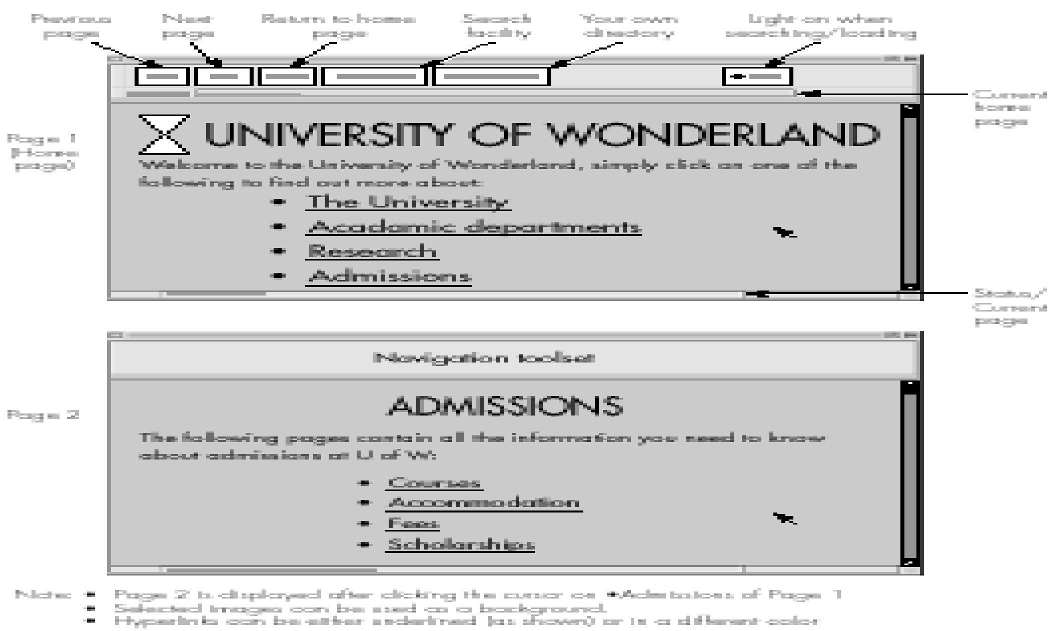
(b)




Hypertext

- Formattedtextthatenablesarelatedsetofdocuments—normallyreferredto as pages—to be created which have defined linkage points—referred to as hyperlinks —between each other
- Fig2.9

**Figure 2.9 Example of an electronic document written in hypertext.**



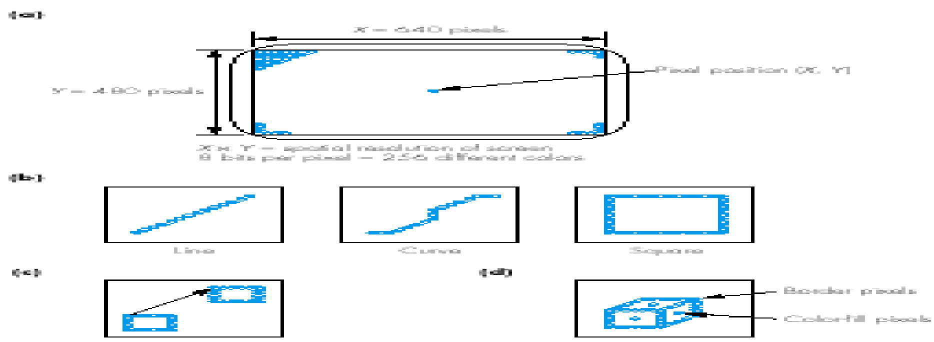
Images

- Image are displayed in the form of a two-dimensional matrix of individual picture elements—known as pixels or pels

Graphics

- Fig2.10
- Twoformsofrepresentationofacomputergraphic:ahigh-levelversion (similartothesourcecodeofahigh-levelprogram)andtheactualpixel- image of the graphic (similar to the byte-string corresponding to the low-level machine code—bit-map format)
- Standardized forms of representation such as GIF (graphical interchange format) and TIFF (tagged image file format)

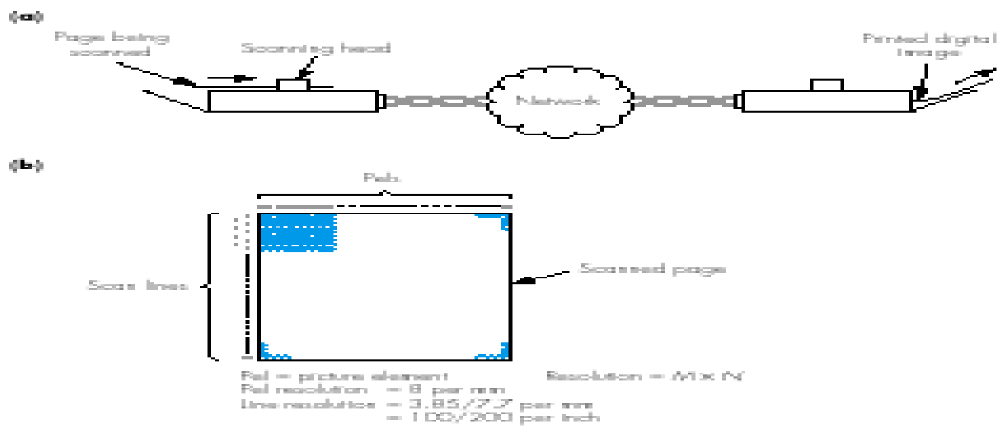
Figure 2.10 Graphics principles: (a) example screen format; (b) some simple object examples; (c) effect of changing position attribute; (d) solid objects.




## Digitizeddocuments

- **Fig2.11**
- **A single binary digit to represent each pel, a 0 for a white pel and a 1 for a black pel**

Figure 2.11 Facsimile machine principles: (a) schematic; (b) digitization format.



Digitizedpictures

- Colorprinciples
- Awhole spectrumofcolors—known asacolorgamut—can beproducedby using different proportions of red(R), green(G), and blue (B)
- Fig2.12
- Additive colormixingproducingacolorimage onablacksurface
- Subtractivecolormixingforproducingacolorimageonawhitesurface
- Fig2.13

**Figure 2.12 Color derivation principles: (a) additive color mixing; (b) subtractive color mixing.**

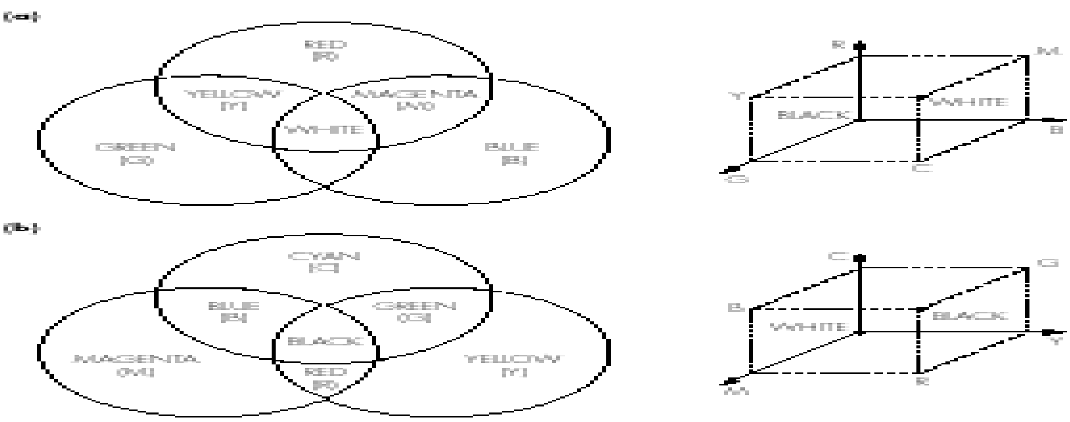
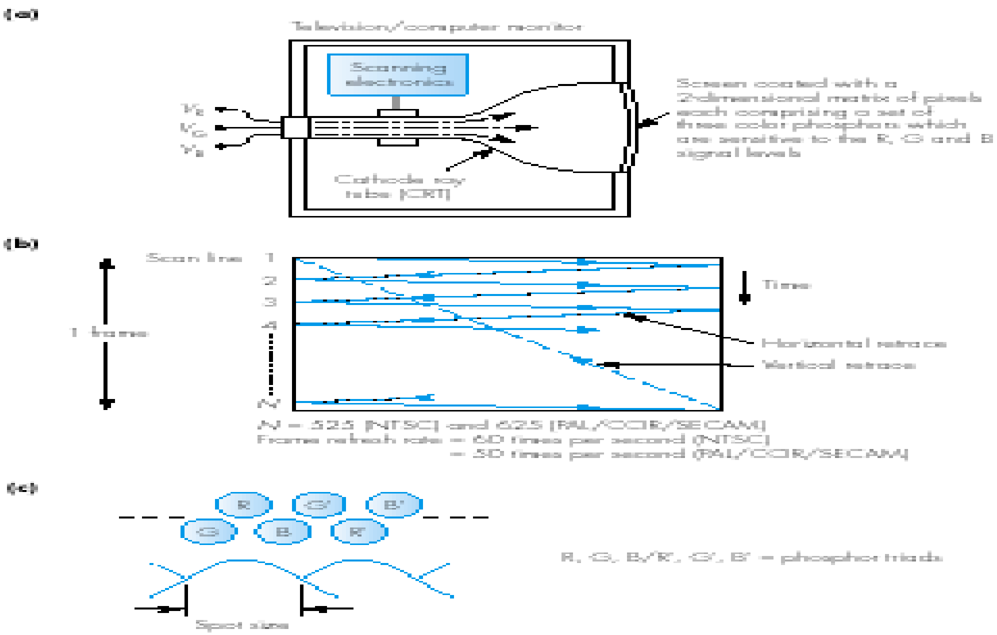



**Figure 2.13 Television/computer monitor principles: (a) schematic; (b) raster-scan principles; (c) pixel format on each scan line.**




## 2.4.3Digitizedpictures

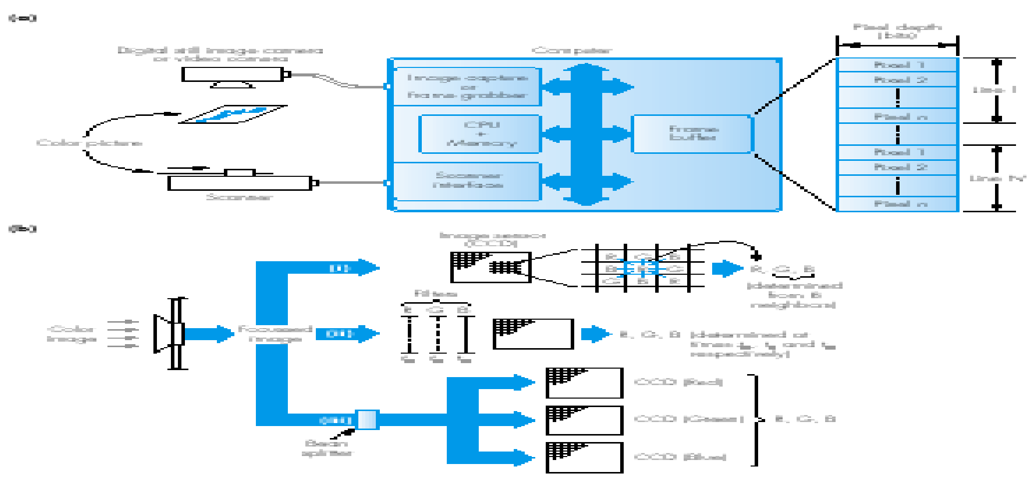
- Raster-scanprinciples
- Progressivescanning
- Eachcompletesetofhorizontalscaniscalledaframe
- Thenumberofbitsperpixelisknownasthepixeldepthanddeterminesthe range of different colors
- Aspectratio
- Boththenumberofpixelsperscannedlineandthenumberoflinesperframe
- Theratioofthescreenwidthtothescreenheight
- National Television Standards Committee (NTSC), PAL(UK), CCIR(Germany), SECAM (France)
- Table2.1

**Table 2.1 Example display resolutions and memory requirements.**

| Standard | Resolution | Number of colors | Memory required per frame (bytes) |
|---|---|---|---|
| VGA | 640 × 480 × 8 | 256 | 307.2 kB |
| XGA | 640 × 480 × 16<br>1024 × 768 × 8 | 64 K<br>256 | 614.4 kB<br>786.432 kB |
| SVGA | 800 × 600 × 16<br>1024 × 768 × 8<br>1024 × 768 × 24 | 64 k<br>256<br>16 M | 960 kB<br>786.432 kB<br>2359.296 kB |

- Digitalcamerasandscanners
- Animageiscapturedwithinthecamera/scannerusinganimagesensor
- Atwo-dimensionalgridoflight-sensitivecellscalledphotosites
- Awidely-usedimagesensorisacharge-coupleddevice(CCD)
- Fig2.16

Figure 2.16 Color image capture: (a) schematic; (b) RGB signal generation alternatives.



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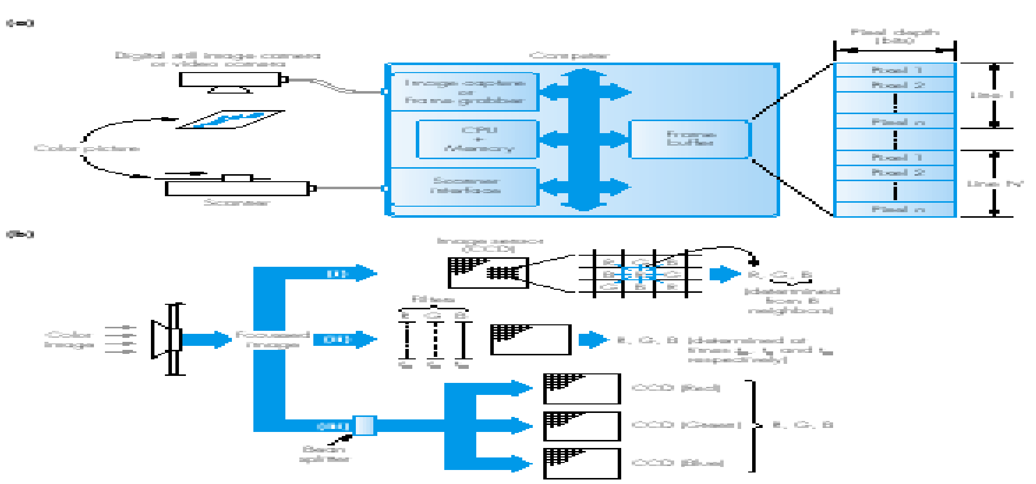


## Audio

- Thebandwidthofatypicalspeechsignalisfrom50Hzthroughto10kHz; music signal from 15 Hz through to 20kHz

- Thesamplingrate:20ksps(2*10kHz)forspeechand40ksps(2*20kHz)for music
- Music stereophonic (stereo) results in a bit rate double that of a monaural(mono) signal
- Example2.4

2.5.2 CD-quality audio

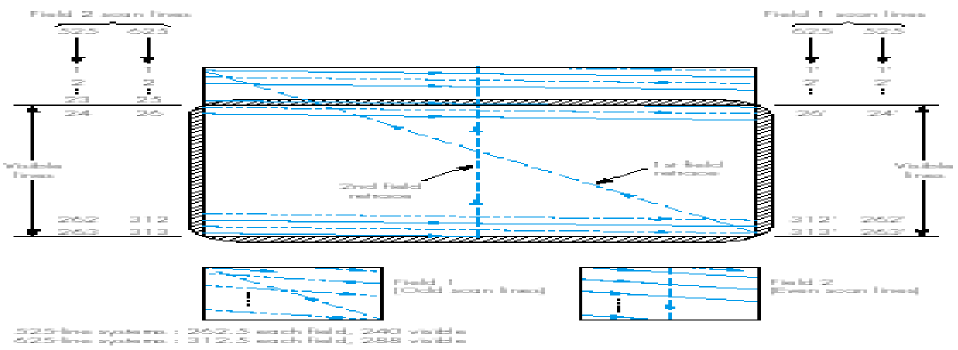
- Bitrateperchannel $= sampling\ rate * bitspersample = 44.1 \times 10^3 \times 16 = 705.6 kbps$
- Totalbitrate=2*705.6=1.411Mbps
- Example2.5

Video

Broadcasttelevision

- Scanningsequence
- Itisnecessarytouseaminimumrefreshrateof50timespersecondtoavoid flicker
- Arefreshrateof25timespersecondissufficient
- Field:thefirstcomprisingonlytheoddscanlinesandthesecondtheeven scan lines
- Thetwofieldarethenintegratedtogetherinthetelevisionreceiverusinga technique known as interlaced scanning
- Fig2.19
- Thethreemainpropertiesofacolorsource
  - Brightness
  - Hue:thisrepresentstheactualcolorofthesource
  - Saturation:thisrepresentsthestrengthorvividnessofthecolor

Figure 2.19 Interlaced scanning principles.



- Thetermluminanceisusedtorefertothebrightnessofasource
- Thehueandsaturationarereferredtoasitschrominance

$$Y_s=0.299R_s+0.587G_s+0.144B_s$$

- Where Ys is the amplitude of the luminance signal and Rs,Gs and Bs are themagnitudes of the three color component signals

- Thebluechrominance(Cb),andtheredchrominance(Cr)arethenusedto represent hue and saturation
- Thetwocolordifferencesignals:

$$C_b=B_s-Y_s \qquad C_r=R_s-Y_s$$

- InthePALsystem,CbandCrarereferredtoas$U$and$V$respectively

$$PAL: Y=0.299R+0.587G+0.114B \quad U=0.493(B-Y)$$

$$V=0.877(R-Y)$$

- TheNTSCsystemformtwodifferentsignalsreferredtoas$I$and$Q$

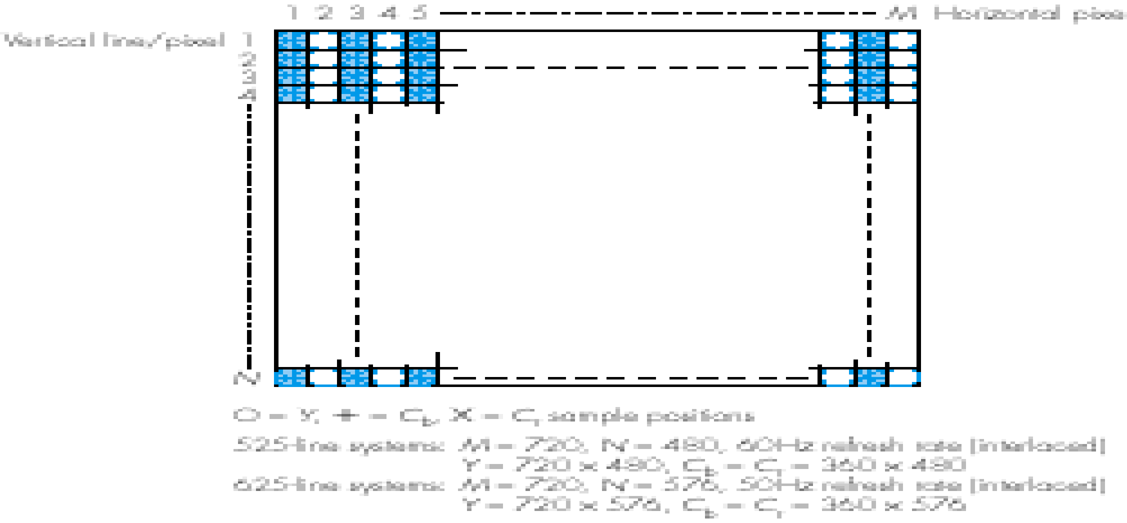
$$NTSC: Y=0.299R+0.587G+0.114B \quad I=0.74(R-Y)-0.27(B-Y)$$

$$Q=0.48(R-Y)+0.41(B-Y)$$

Digitalvideo

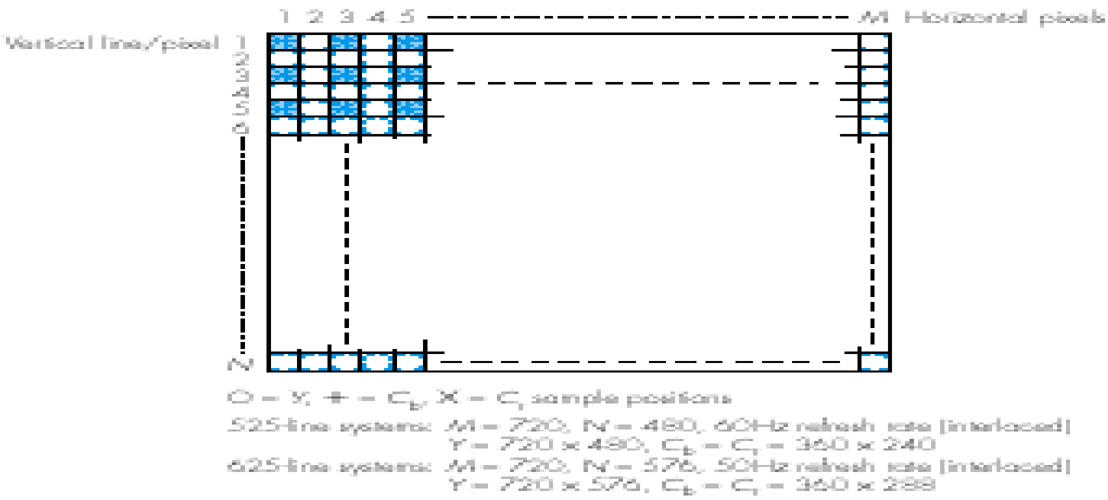
- Eyehaveshownthattheresolutionoftheeyeislesssensitiveforcolorthanit is for luminance
- 4：2：2format
- TheoriginaldigitizationformatusedinRecommendationCCIR-601
- Alinesamplingrateof13.5MHzforluminanceand6.75MHzforthetwo chrominance signals
- Thenumberofsamplesperlineisincreasedto720
- Thecorrespondingnumberofsamplesforeachofthetwochrominance signals is 360 samples per active line
- Thisresultsin4Ysamplesforevery2Cb,and2Crsamples
- Thenumbers480and576beingthenumberofactive(visible)linesinthe respective system
- Fig.2.21
- Example2.7

Figure2.21Samplepositionswith4:2:2digitizationformat.




- 4 : 2 : 0formatisusedindigitalvideobroadcastapplications
- Interlacedscanningisusedandtheabsenceofchrominancesamplesinalternative lines
- Thesameluminanceresolutionbuthalfthechrominanceresolution
- Fig2.22

Figure2.22Samplepositionsin4:2:0digitizationformat.




525-linesystem

$Y$=720×480

$C_b$=$C_r$=360×240

625-linesystem

$Y$=720×480

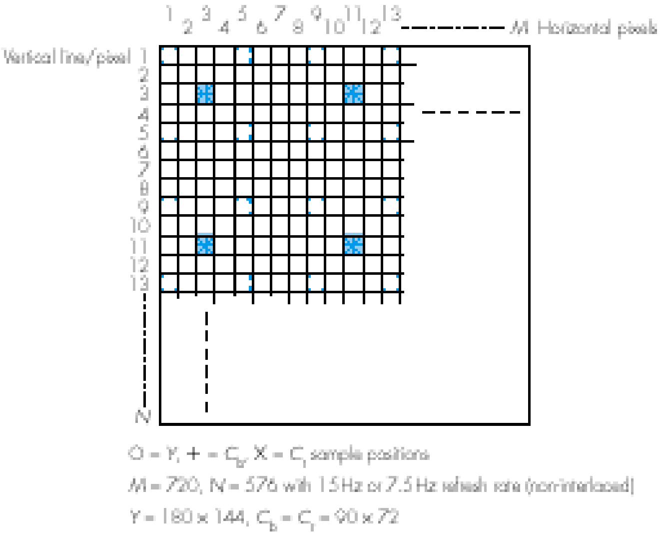
$C_b$=$C_r$=360×288

$$13.5\times10^{6}\times8+2\left(3.375\times10^{6}\times8\right)=162Mbps$$

- HDTVformats:theresolutiontothenewer16/9wide-screentubescanbeup to 1920*1152 pixels
- Thesourceintermediateformat(SIF)giveapicturequalitycom parablewith video recorders(VCRs)
- Thecommonintermediateformat(CIF)foruseinvideoconfere ncing applications
- Fig2.23
- ThequarterCIF(QCIF)foruseinvideotelephony applications
- **Fig2.24**
- **Table2.2**

**Figure 2.23 Sample positions for**

**SIF and CIF. Figure 2.24 Sample**




video digitization formats.

| System | Spatial resolution | Temporal resolution |
|---|---|---|
| 525-line | Y = 640 × 480<br>$C_b = C_r$ = 320 × 240 | 60 Hz |
| 625-line | Y = 768 × 576<br>$C_b = C_r$ = 384 × 288 | 50 Hz |
| 525-line | Y = 320 × 240<br>$C_b = C_r$ = 160 × 240 | 30 Hz |
| 625-line | Y = 384 × 288<br>$C_b = C_r$ = 192 × 144 | 25 Hz |
| | Y = 384 × 288<br>$C_b = C_r$ = 192 × 144 | 30 Hz |
| | Y = 192 × 144<br>$C_b = C_r$ = 96 × 72 | 15/7.5 Hz |

## RECOMENDDEDQUESTIONS:

1. Expalincodeword,analogsignal,signalencoder,signaldecoder?[06]
2. Define—bandwidth||?explain—bandlimitingchannel||?[05]
3. Explainnyquistsamplingtheorem&nyquistrate?[04]
4. Definethemeaningoftermquantizationinterval&howth isinfluencesthe accuracy of the sampling process of an analog signal? [06]
5. Explain a)unformatted/plaintext.
   b) formatted/richtext.
   c) Hypertext. [06]
6. Differentiateformattedtext&unformattedtext?Explaino rigintheacronym WYSIWYG? [05]
7. Explainbriefly:visualobject,freeformobject,clipart,3-Dobjects.[04]
8. Explainscanning,pels,digitizationprincipleswrftofascimilemachines?[08]
9. Definetheaspectratioofadisplayscreen.givetwoexamplesfo rcurrentwidely used screen sizes? [05]
10. Derivethe timetotransmitan image with eachtypeofdisplayassuming a bitrate of 56 kbps, 1.5Mbps?[06]
11. Definetext&image.[03]
12. Defineaudio&video.[03]
13. Compareformatted&unformattedtext.[08]
14. Whatisrendering&clipart?[02]
15. Whatisflicker&framerefreshrate?[04]
16. WhatisNTSC&PAL?[10]
17. Whatissample&hold,Quantizer?[06]
18. Defineaspectratio&pixeldepth.[06]