**UNIT III - SOURCE CODES, LINE CODES & ERROR CONTROL**

**(Qualitative only)**

Primary communication – entropy, properties, BSC, BEC, source coding : Shaum, Fao, Huffman coding : noiseless coding theorum, BW – SNR trade off codes: NRZ, RZ, AMI, HDBP, ABQ, MBnB codes : Efficiency of transmissions, error control codes and applications: convolutions & block codes.

**SESSION PLAN**

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| --- | --- |
| Session 1 | * Introduction to coding , Entropy, Properties
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| Session 2 | * Binary Symmetric Channel, Binary Erase Channel
 |
| Session 3 | * Source Coding Theorem, Shannon fano coding Algorithm and Problem
 |
| Session 4 | * Huffman Coding Algorithm and Problem
 |
| Session 5 | * Noiseless Coding Theorem, Bandwidth SNR Trade Off
 |
| Session 6 | * NRZ, RZ, AMI
 |
| Session 7 | * HDBP, ABQ, MBnB
 |
| Session 8 | * Efficiency of transmission, Error control codes, Error detection, Parity, Redundancy, Checksum, CRC codes
 |
| Session 9 | * Error correction, Forward Error Correction, Hamming Code
* Application, Convolution Codes, Block Codes
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**UNIT – III**

**SOURCE CODES, LINE CODES & ERROR CONTROL**

**SESSION – 1**

Introduction: SOURCE CODES, LINE CODES & ERROR CONTROL (Learning Aid & Methodology: Brainstorming)

Source codes, line codes & error control are being well-known terms the faculty can begin the session by conducting a brainstorming activity so as to know the knowledge of the learns.

References:

1. elearning.vtu.ac.in/P4/EC63/S11.pdf‎
2. www.eccpage.com/‎
3. www.cs.tut.fi/kurssit/TLT-5406/LectureNotes/83050f.pdf‎

Introduction to coding (Learning Aid & Methodology: Presentation)

 The concept of Introduction to coding had been explained by presenting about Tasks and processes, threads, asynchronous input through PowerPoint presentation.

References:

1. www.sagepub.com/upm-data/24614\_01\_Saldana\_Ch\_01.pdf‎
2. www.cs.technion.ac.il/~ronny/ecc.html‎
3. people.csail.mit.edu/madhu/FT01/‎

Entropy, Properties (Learning Aid & Methodology: Presentation)

 The Entropy, Properties had been explained through PowerPoint presentation.

References:

1. farside.ph.utexas.edu/teaching/sm1/lectures/node44.html‎
2. https://web.cse.msu.edu/~cse842/Papers/CoverThomas-Ch2.pdf‎
3. www.renyi.hu/~revesz/epy.pdf‎

Conclusion & Summary (Learning Aid & Methodology: Recall by keywords, Quiz)

 The students are instructed to list out the important words. The following are some of the keywords: Coding, entropy, properties f entropy, Source coding.

**SESSION – 2**

RECAP: Introduction to coding, Entropy, Properties (Learning Aid & Methodology: Unspoken word, Brainstorming)

 The faculty has to give the description of concepts Introduction to coding, Entropy, Properties and getting the relevant important words as the answer from the students through brainstorming.

References:

1. What is meant by coding?
2. What is the need for coding?
3. How coding were generated?

Binary Symmetric Channel (Learning Aid & Methodology: Group Discussion and Presentation)

 The Binary Symmetric Channel is discussed through Group discussion and PowerPoint Presentation.

References:

1. math.arizona.edu/~mleslie/files/capBSC.pdf‎
2. www.mathworks.in/help/comm/ref/**binarysymmetricchannel**.html‎
3. www.britannica.com/EBchecked/topic/65583/**binary**-**symmetric**-**channel**‎

Binary Erase Channel (Learning Aid & Methodology: Board activity Presentation)

 The Binary Erase Channel is discussed through Board presentation and PowerPoint Presentation.

References:

1. http://www.google.co.in/url?sa=t&rct=j&q=binary%20erasure%20channel&source=web&cd=2&cad=rja&ved=0CDkQFjAB&url=http%3A%2F%2Fwifo.eecs.berkeley.edu%2Fwiki%2Flib%2Fexe%2Ffetch.php%2Fcodingtheory%3Amct\_threea.pdf%3Fid%3Dcodingtheory%253Areading\_group%26cache%3Dcache&ei=rNoRUoDkIcjUrQf06IDADw&usg=AFQjCNFPgr1671IQ6LLXaU5XCswwlLD9\_w&bvm=bv.50768961,d.bmk
2. <http://www.google.co.in/url?sa=t&rct=j&q=binary%20erasure%20channel&source=web&cd=9&cad=rja&ved=0CFUQFjAI&url=http%3A%2F%2Fwww.wiziq.com%2Ftutorial%2F166163-6-441-8-Channel-capacity-binary-symmetric-and-erasure-channels&ei=rNoRUoDkIcjUrQf06IDADw&usg=AFQjCNFzbNMSeRobQD118UdSDPW2NUJJ0w&bvm=bv.50768961,d.bmk>
3. webee.technion.ac.il/people/sason/PSU04.pdf‎

Conclusion & Summary: (Learning Aid & Methodology: Recall by keywords, Quiz)

 The students are instructed to list out the important technical words. The following are some of the keywords: Binary Channel, Memory less Channel, Information, Binary Symmetric Channel, Binary Erase Channel.

**SESSION – 3**

Recap: Binary Symmetric Channel, Binary Erase Channel (Learning Aid & Methodology: Questions & Brainstorming)

 The faculty has to prepare the questionnaire consisting of few questions. The students were asked with the questions and the answers were obtained.

* What is meant by Binary Symmetric Channel?
* What is meant by Binary Erase Channel?

Source Coding Theorem: (Learning Aid & Methodology: Role play)

 Introduction was given as presentation. The Source Coding Theorem are acted by the students as drama. They did the drama by assigning steps and played.

References

1. www.cs.cmu.edu/~aarti/Class/10704/lec8-src**coding**Huffman.pdf‎
2. [www.kim-bostroem.de/Library/Notes/Shannon.pdf](http://www.kim-bostroem.de/Library/Notes/Shannon.pdf)
3. http://www.google.co.in/url?sa=t&rct=j&q=source%20coding%20theorem&source=web&cd=9&cad=rja&sqi=2&ved=0CFYQFjAI&url=http%3A%2F%2Fwww.maths.bris.ac.uk%2F~enxkw%2FIT\_BCCS\_Lecture\_Notes\_files%2Flecture-3-source-coding-theorem.pdf&ei=ZR4XUu2fFMPNrQeenIHABg&usg=AFQjCNFUMVbhP8qs-g9JHxDsPqSqgg5Q7A&bvm=bv.51156542,d.bmk

Shannon fano coding Algorithm and Problem (Learning Aid & Methodology: Role play)

 The students were given with the steps of Shannon fano coding Algorithm and Problem. The students have to prepare them with name cards (Names of Blocks as their name). By assigning themselves as different codewords, they had to given the explanation.

References

1. www.ics.uci.edu/~dan/pubs/DC-Sec3.html‎
2. [www.youtube.com/watch?v=MAOuXKkz-SI](http://www.youtube.com/watch?v=MAOuXKkz-SI)
3. www.cse.ust.hk/~golin/Talks/**Shannon**\_**Coding**\_Extensions.pdf‎
4. www.binaryessence.com/dct/en000046.htm‎

Conclusion & Summary (Learning Aid & Methodology: Recall by keywords Quiz)

 The students were asked to recall and write the important technical key words of this session:

Some of the keywords are: Binary Symmetric Channel, Binary Erase Channel, Source Coding Theorem, Shannon fano coding Algorithm and Problem

**SESSION – 4**

RECAP: Source Coding Theorem, Shannon fano coding Algorithm and Problem (Learning Aid & Methodology: Group discussion)

 A particular group was assigned, the last day itself; from that group after a small discussion one student from that group have to give the short seminar on the last session topics: Source Coding Theorem, Shannon fano coding Algorithm and Problem.

Huffman Coding Algorithm (Learning Aid & Methodology: Board activity Presentation)

 Huffman Coding Algorithm is explained through the presentation through board and PowerPoint presentation.

References

1. www.huffmancoding.com/my-uncle/huffman-algorithm‎
2. www.cs.nyu.edu/~melamed/courses/102/lectures/huffman.ppt‎
3. [www.cstutoringcenter.com/tutorials/algorithms/huffman.php](http://www.cstutoringcenter.com/tutorials/algorithms/huffman.php)
4. www.cs.cf.ac.uk/Dave/Multimedia/node210.html‎

Huffman Coding Problem (Learning Aid & Methodology: Board activity Presentation)

 Huffman Coding Problem are explained through the presentation through board and PowerPoint presentation.

References

1. www.huffmancoding.com/my-uncle/huffman-algorithm‎
2. www.cs.nyu.edu/~melamed/courses/102/lectures/huffman.ppt‎
3. [www.cstutoringcenter.com/tutorials/algorithms/huffman.php](http://www.cstutoringcenter.com/tutorials/algorithms/huffman.php)
4. www.cs.cf.ac.uk/Dave/Multimedia/node210.html‎

Conclusion & Summary (Learning Aid & Methodology: Learner-led presentation)

 A student (who is already assigned) was asked to come on to the stage to give the presentation on the today’s session in short.

 Covered the topics: Huffman Coding Algorithm, Huffman Coding Problem

**SESSION – 5**

RECAP: Huffman Coding Algorithm and Problem (Learning Aid & Methodology: Short seminar Presentation)

 The recap on the last session topic Huffman Coding Algorithm and Problem is presented by the students as short seminar.

Noiseless Coding Theorem (Learning Aid & Methodology: Explanation)

 The following topics were presented to the students - Noiseless Coding Theorem

References

1. ccit.kaist.ac.kr/EE326\_Fall/%5B2%5D**Noiseless**-**Coding**.pdf‎
2. <http://www.google.co.in/url?sa=t&rct=j&q=noiseless%20coding%20theorem%20&source=web&cd=4&cad=rja&ved=0CEMQFjAD&url=http%3A%2F%2Fwww.umsl.edu%2F~siegelj%2Finformation_theory%2Finformation%2FShannonNCT.html&ei=Fx8XUun6KdHHrQf6kIDwDw&usg=AFQjCNGKOGWYbASfRdo5QDbCLNj2a0oEFA&bvm=bv.51156542,d.bmk>
3. http://www.google.co.in/url?sa=t&rct=j&q=noiseless%20coding%20theorem%20&source=web&cd=4&cad=rja&ved=0CEMQFjAD&url=http%3A%2F%2Fwww.umsl.edu%2F~siegelj%2Finformation\_theory%2Finformation%2FShannonNCT.html&ei=Fx8XUun6KdHHrQf6kIDwDw&usg=AFQjCNGKOGWYbASfRdo5QDbCLNj2a0oEFA&bvm=bv.51156542,d.bmk

Bandwidth SNR Trade Off (Learning Aid & Methodology: Board activity, Presentation)

 Bandwidth SNR Trade Off is discussed through board and presentation.

References

1. http://www.google.co.in/url?sa=t&rct=j&q=bandwidth%20snr%20trade%20off&source=web&cd=2&cad=rja&ved=0CDMQFjAB&url=http%3A%2F%2Fwww.physicsforums.com%2Fshowthread.php%3Ft%3D423218&ei=OB8XUqb8OouYrAe-w4B4&usg=AFQjCNHicQuUSxKwkhzMeAyHsYgWk1H39w&bvm=bv.51156542,d.bmk
2. <http://www.google.co.in/url?sa=t&rct=j&q=bandwidth%20snr%20trade%20off&source=web&cd=7&cad=rja&ved=0CF8QFjAG&url=http%3A%2F%2Fusers.ecs.soton.ac.uk%2Fsqc%2FEL334N%2FInfThe-L5.pdf&ei=OB8XUqb8OouYrAe-w4B4&usg=AFQjCNG-SMJnCeeCkS9Iy2mf9WGI86Xozg&bvm=bv.51156542,d.bmk>
3. http://www.google.co.in/url?sa=t&rct=j&q=bandwidth%20snr%20trade%20off&source=web&cd=9&cad=rja&ved=0CG0QFjAI&url=http%3A%2F%2Fwww.revisemri.com%2Fquestions%2Fpulse\_sequences%2Fsnr\_rbw&ei=OB8XUqb8OouYrAe-w4B4&usg=AFQjCNHsmtKHJrlPgcd8FDTBSffNzQ3Qmw&bvm=bv.51156542,d.bmk

Conclusion & Summary (Learning Aid & Methodology: Rapid fire quiz)

 This session was concluded with the rapid fire of simple questions to the audience.

1. What is meant by Noiseless channel?
2. What is meant by Channel capacity?
3. What is meant by effective utilization of channel BW?

**SESSION – 6**

**RECAP: Noiseless Coding Theorem, Bandwidth SNR Trade** **Off** (Learning Aid & Methodology: Show and tell)

 The powerpoint was shown to the students on the topics Noiseless Coding Theorem, Bandwidth SNR Trade Offwhich was explained in the last session. That was explained in short by the student.

**NRZ, RZ**: (Learning Aid & Methodology: Board activity & Presentation)

 The concept of NRZ, RZ with example was discussed and summarized through presentation

References:

1. www.opticsinfobase.org/viewmedia.cfm?URI=jlt-16-3-340&seq=0
2. www.inphi.com/.../**nrz**-to-**rz**-data-conversion-using-high-speed-orand

**AMI** (Learning Aid & Methodology: Board activity & Presentation)

 The concept of AMI with example was discussed and summarized through presentation

References:

1. [www.**ami**india.co.in/](http://www.amiindia.co.in/)
2. en.wikipedia.org/wiki/**Ami**‎
3. www.**ami**project.org/‎

**Conclusion & Summary** (Learning Aid & Methodology: Tit-for-Tat)

 The set of questions (Definitions) were written by the two different groups, five per group, and they are instructed to fire the questions alternatively. One group framed the questions from the first subtopic and the next five questions were framed by another group from the second subtopic.

Some questions from Group A are:

1. What is NRZ?
2. What is RZ?

Some questions from Group B are:

1. What is AMI?
2. What is the application of AMI?

**SESSION – 7**

**RECAP:** **NRZ, RZ, AMI** (Learning Aid & Methodology: Quiz & Presentation)

 Some questions were prepared by the faculty on the topic **NRZ, RZ, AMI**

**HDBP, ABQ**: (Learning Aid & Methodology: Board activity & Presentation)

The following concepts of HDBP, ABQ were explained by the faculty through board presentation.

References:

1. www.svce.ac.in/departments/eee/Odd/V%20sem/EC2311.pdf‎
2. www.mce.edu.in/EC2311-CE.pdf‎

**MBnB**: (Learning Aid & Methodology: Board activity & Presentation)

The following concepts of MBnB were explained by the faculty through board presentation.

References:

1. [www.srividyaengg.ac.in/svcetwp/wp-content/uploads/.../EC2311.pd](http://www.srividyaengg.ac.in/svcetwp/wp-content/uploads/.../EC2311.pd)f
2. www.manta.com/c/mtg5ptt/**mbnb**-financial-inc‎

**Conclusion & Summary** (Learning Aid & Methodology: Recall by key words)

 The students were asked to list out the important words which are discussed in this session. Then the keywords are consolidated by the faculties and described in short.

 The keywords are:

* HDBP
* ABQ
* MBnB

**SESSION – 8**

RECAP: **HDBP, ABQ, MBnB** (Learning Aid & Methodology: Questions)

The recap of Example Problems based on RMS and EDF algorithms topic was given by asking questions with the learners.

* HDBP
* ABQ
* MBnB

**Efficiency of transmission, Error control codes, Error detection**: (Learning Aid & Methodology: Presentation)

 Efficiency of transmission, Error control codes, Error detection was presented through PowerPoint presentation and discussed. Blocking or nonblocking, shared memory and message passing, semaphore were presented.

References:

1. <https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CCkQFjAA&url=http%3A%2F%2Fwww.chalmers.se%2Fcse%2FEN%2Fresearch%2Fresearch-groups%2Fpublications-from%2Fphd-theses%2FdownloadFile%2FattachedFile_1_f0%2FEfficient_Coding_Techniques_for_Networks__amp__Channels_with_Transmission_Errors%3Fnocache%3D1348136084.45&ei=ocMyUoKgLsWLrQenp4G4Ag&usg=AFQjCNGqvkDOmXrtDpnTk8PPv1HsuImwKQ&bvm=bv.52164340,d.bmk>
2. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&ved=0CCsQFjAB&url=http%3A%2F%2Fciteseerx.ist.psu.edu%2Fviewdoc%2Fsummary%3Fdoi%3D10.1.1.40.9313&ei=ocMyUoKgLsWLrQenp4G4Ag&usg=AFQjCNGEH-NJsxKTSrj5OM1tu2L7mXkGJg&bvm=bv.52164340,d.bmk

**Parity, Redundancy, Checksum, CRC codes**: (Learning Aid & Methodology: Presentation)

 Parity, Redundancy, Checksum, CRC codes was presented through PowerPoint presentation and discussed. units operate relatively autonomously, communication packets were presented.

References:

1. <https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&ved=0CDoQFjAD&url=http%3A%2F%2Fen.kioskea.net%2Fcontents%2F59-error-checking&ei=2sMyUr2-L87irAe40YHoAw&usg=AFQjCNGPm7oieuiHXbFXFZ1hRJ4WLOGrpA&bvm=bv.52164340,d.bmk>
2. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&cad=rja&ved=0CE0QFjAG&url=http%3A%2F%2Fwww.ti.com%2Fgeneral%2Fdocs%2Flit%2Fgetliterature.tsp%3FbaseLiteratureNumber%3DSPRA530%26track%3Dno&ei=2sMyUr2-L87irAe40YHoAw&usg=AFQjCNHTwZ3LPe32y-gyRz1yROnSM1u0bg&bvm=bv.52164340,d.bmk

**Conclusion & Summary** (Learning Aid & Methodology: Recall by keywords & Quiz)

The students are instructed to list out the important technical words. The following are some of the keywords: Efficiency of transmission, Error control codes, Error detection, Parity, Redundancy, Checksum, CRC codes.

**SESSION – 9**

**RECAP: Efficiency of transmission, Error control codes, Error detection, Parity, Redundancy, Checksum, CRC codes** (Learning Aid & Methodology: Short Seminar)

 The recap on the last session topic Efficiency of transmission, Error control codes, Error detection, Parity, Redundancy, Checksum, CRC codes were presented by the students as short seminar.

**Error correction, Forward Error Correction, Hamming Code** (Learning Aid & Methodology: Board activity & Presentation)

 Error correction, Forward Error Correction, Hamming Codefor the analysis of scheduling policies were presented in board.

References:

1. en.wikipedia.org/wiki/**Forward**\_**error**\_**correction**‎
2. www.slideshare.net/ibrar562/**error**-**correction**-and-**hamming**-**code**-ibrar‎
3. www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA505116‎

**Application, Convolution Codes, Block Codes** (Learning Aid & Methodology: Board activity & Presentation)

 Application, Convolution Codes, Block Codes were presented in board with the example of Scheduling and context switching overhead.

References:

1. www.elec.uow.edu.au/staff/wysocki/dspcs/papers/015.pdf‎
2. wits.ice.nsysu.edu.tw/course/.../9221/CC-**ConvolutionalCode**(II).pdf
3. www.engr.sjsu.edu/rmorelos/ee296f05/viterbi\_1971.pdf‎

**Conclusion & Summary**: (Learning Aid & Methodology: Learner-led presentation)

 The faculty can divide the learners into two teams and assign the topics. Allow an internal discussion for 5 minutes. The faculty will instruct one member from first team to team to narrate the concept. After the completion one member from the second team was instructed to narrate the second concept.