**UNIT II - DIGITAL COMMUNICATION**

Pulse modulations – concepts of sampling and sampling theormes, PAM, PWM, PPM, PTM, quantization and coding : DCM, DM, slope overload error. ADM, DPCM, OOK systems – ASK, FSK, PSK, BSK, QPSK, QAM, MSK, GMSK, applications of Data communication.

**SESSION PLAN**

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| Session 1 | * Pulse Modulation * PAM,PPM and PWM * Pulse Code Modulation |
| Session 2 | * Sampling Theorem * Natural Sampling * Flat top Sampling |
| Session 3 | * Quantization * Quantization Error * PCM System |
| Session 4 | * PCM encoder and decoder * Delta Modulation * Slope overload and granular noise |
| Session 5 | * Adaptive Delta Modulation Transmitter and Receiver, Differential PCM transmitter and receiver, Amplitude Shift Keying |
| Session 6 | * Frequency shift keying transmitter and receiver * Phase shift keying * Binary Phase shift keying transmitter and receiver |
| Session 7 | * Quadrature Phase Shift Keying Transmitter and Receiver, Bandwidth consideration of QPSK |
| Session 8 | * Quadrature Amplitude Modulation Transmitter and Receiver, Bandwidth consideration of QAM |
| Session 9 | * Minimum shift keying transmitter and receiver * Gaussian minimum shift keying transmitter and receiver |

**SESSION – 1**

**Introduction: Digital Communication** (Learning Aid & Methodology: Brain stroming & Questions)

Digital Communication is being a well-known term; the faculty can begin the session by conducting a brainstorming activity so as to know the knowledge of the learners.

**Pulse Modulation, PAM, PPM and PWM (**Learning Aid & Methodology:Board activity, Presentation)

The concept of Pulse Modulation, PAM, PPM and PWM is been explained board presentaion.

References:

1. Pulse Modulation :
   1. <http://www.slideshare.net/saqibalvie/pulse-modulation>
   2. <http://www.thefreedictionary.com/pulse+modulation>
2. PAM, PPM, PWM
   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%2Fs3.amazonaws.com%2Fcramster-resource%2F104616_Pulse_modulation(pcm%2Cpwm%2Ccommuniation).ppt&ei=_iTyUaHyFcGHrgfylIGADA&usg=AFQjCNE6GmuwKlN8YgfKq4Om3MlEcuvA7Q&sig2=e0lmR0o3EgxFEHY8dA9UVw&bvm=bv.49784469,d.bmk>
   2. <http://bahmaei.persiangig.com/document/Maghalat/Pulse%20Modulation.ppt>

**Pulse Code Modulation** (Learning Aid & Methodology: Questions, Board activity, Presentation)

The concept Pulse Code Modulation is been known to the students, the questions were asked by the staff and answers were obtained by discussion. Then the concept was explained by presentation.

References:

1. **Pulse Code Modulation**
   1. <http://www.acroam.com/pulse-code-modulation.html>
   2. <http://www.slideshare.net/abhijaysisodia/pulse-code-modulation>
   3. <http://searchnetworking.techtarget.com/definition/pulse-code-modulation-PCM>
   4. <http://www.youtube.com/watch?v=YJmUkNTBa8s>

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

The students are instructed to list out the important.

The following are some of the keywords: *Pulse Modulation, PAM, PPM and PWM, Pulse Code Modulation*

**SESSION – 2**

**Recap: Pulse Modulation, PAM, PPM and PWM, Pulse Code Modulation** (Learning Aid & Methodology: Questions Brainstorming)

The faculty has to give the description of concepts in short and getting the relevant technical term as the answer from the students.

1. What is meant by Pulse modulation?
2. What is meant by PPM?
3. What is meant by PAM?
4. What is meant by PWM?
5. What is meant by PCM?

**Sampling Theorem - Natural Sampling** (Learning Aid & Methodology: Presentation - Chalk & talk)

The faculty asked the students to think on their own about the Sampling process – Natural Sampling as they already learnt in Digital Signal Processing subject. Then the terms are consolidated and explained by the faculty.

References:

1. [www.dspguide.com/ch3/2.htm](http://www.dspguide.com/ch3/2.htm)
2. <http://nptel.iitm.ac.in/courses/IIT-MADRAS/Principles_Of_Communication/pdf/Lecture08_SamplingTheorem.pdf>
3. <http://www.ele.uri.edu/courses/ele436/labs/newhandouts_09/SamplingwithSAMPLEandHOLD.pdf>

**Sampling Theorem - Flat top Sampling** (Presentation - Chalk & talk)

The faculty asked the students to think on their own about the Sampling process – Flat top Sampling as they already learnt in Digital Signal Processing subject. Then the terms are consolidated and explained by the faculty.

References:

1. web.uct.ac.za/depts/staff/rebejide/New%20Folder/**Sampling**.p
2. ocw.nctu.edu.tw/upload/classbfs120912290160453.pd
3. redwood.berkeley.edu/bruno/npb261/aliasing.pd

**Conclusion & Summary:** (Learning Aid & Methodology: Listing Key Points Quiz)

The students are instructed to list out the important technical words. The following are some of the keywords:

Sampling, Sample and Hold circuit, Elements used in S&H Circuit, Nyquest criterion, Natural Sampling, Flat top sampling, idle sampling.

**SESSION – 3**

**RECAP: Sampling Theorem - Natural Sampling, Flat top Samplin**g (Learning Aid & Methodology: Presentation Discussion)

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

1. What is the need for Sampling?
2. Tell me about Sample and Hold circuit.
3. What are the elements used in S&H Circuit?
4. What is Nyquest criterion?
5. What is Natural Sampling?
6. What is flat top sampling?
7. What is idle sampling?

**Quantization (**Learning Aid & Methodology: Presentation)

The concept Quantization, Quantization levels, Step size, quantization noise were explained to the students by the faculty through board presentation.

References:

1. www.debugmode.com/imagecmp/**quantize**.htm‎
2. www.rs-met.com/documents/tutorials/DigitalSignals.pdf‎
3. www.webopedia.com/TERM/Q/quantization.html‎

**Quantization Error, PCM System** (Learning Aid & Methodology: Presentation Brainstorming)

As the students are familiar with Quantization Error, PCM System, the terms related contents were gathered from the students consolidated and explained by the faculty.

References:

1. **Quantization Error**
   1. www.thefreedictionary.com/**quantization**‎
   2. eeweb.poly.edu/~yao/EE3414/**quantization**.pdf‎
2. **PCM System** 
   1. www.webopedia.com/TERM/P/**pulse\_code\_modulation**.html‎

**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: Quantization, Quantization levels, Step size, quantization noise / error, PCM system, PCM, code word, code length, regenerative repeater.

**SESSION – 4**

**Quantization, Quantization Error, PCM System** (Learning Aid & Methodology: Questionnaires

Presentation)

A particular group was assigned, the last day itself; from that group after a small discussion they have to prepare a small questionnaire, one student from that group have to ask the questions to the other group from their questionnaire on ‘Quantization, Quantization Error, PCM System’.

**PCM encoder and decoder** (Learning Aid & Methodology: Presentation)

The concept PCM encoder and decoder was explained and with the students by the faculty through board presentation.

References:

1. www.ele.uri.edu/Courses/ele436/labs/**PCM**.pdf‎
2. radio.ubm.ro/EA/Documente/Cursuri\_Laboratoare/.../Laborator4.pdf‎
3. www.itu.int/rec/T-REC-O.133-199303-I/en‎

**Delta Modulation, Slope overload and granular noise** (Learning Aid & Methodology: Presentation)

The concept of Delta Modulation, Slope overload and granular noise were explained with the students by the faculty through board presentation.

References:

1. <http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Delta_modulation.html>
2. <http://in.answers.yahoo.com/question/index?qid=20091223035935AAlQMWV>
3. <http://www.eng.auburn.edu/~troppel/courses/TIMS-manuals-r5/TIMS%20Experiment%20Manuals/Student_Text/Vol-D1/D1-13.pdf>
4. <http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Digi%20Comm/pdf-m-3/m3l14.pdf>

**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: PCM encoder and decoder, Delta Modulation, Slope overload and granular noise, line codes, NRZ, RZ, Polar and Bipolar representations.

**SESSION – 5**

**Recap: PCM encoder and decoder, Delta Modulation, Slope overload and granular noise** (Learning Aid & Methodology: Presentation - Chalk & Talk)

The recap on the last session topic (PCM encoder and decoder, Delta Modulation, Slope overload and granular noise) and the introduction of the today’s session topic (Adaptive Delta Modulation Transmitter and Receiver) were presented by the faculty.

**Adaptive Delta Modulation Transmitter and Receiver** (Learning Aid & Methodology: Presentation Chalk & talk)

The concept of Adaptive Delta Modulation Transmitter and Receiver was explained with the students by the faculty through board presentation.

References:

1. <https://www.google.com/patents/US4215311>
2. www.wisegeek.com/what-is-**delta**-**modulation**.htm‎

**Differential PCM transmitter and receiver, Amplitude Shift Keying** (Learning Aid & Methodology: Demonstration)

This topic Differential PCM transmitter and receiver, Amplitude Shift Keying were presented through board presentation and video demonstration.

References:

1. <http://www.eng.auburn.edu/~troppel/courses/TIMS-manuals-r5/TIMS%20Experiment%20Manuals/Student_Text/Vol-D1/D1-15.pdf>
2. <http://www.slideshare.net/sc09b093/adaptive-delta-modulation-of-speech-signal>
3. <http://www.cmlmicro.com/products/CMX649_Adaptive_Delta_Modulation/>

**Conclusion & Summary** (Learning Aid & Methodology: Listing Key Points, Quiz)

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

1. What is Adaptive Delta Modulation?
2. How the noises of PCM eliminated in DM?
3. What is the extra element involved in Adaptive DM compared to DM?
4. What are the elements of ADM Receiver?

**SESSION – 6**

**Recap: Adaptive Delta Modulation Transmitter and Receiver, Differential PCM transmitter and receiver, Amplitude Shift Keying** (Learning Aid & Methodology: Presentation Discussion)

The concept of Adaptive Delta Modulation Transmitter and Receiver, Differential PCM transmitter and receiver, Amplitude Shift Keying was explained and discussed with the students by the faculty through board presentation.

**Frequency shift keying transmitter and receiver** (Learning Aid & Methodology: Presentation)

These Frequency shift keying transmitter and receiver were discussed through presentation.

References:

1. <http://www.hoperf.com/rf/module/fsk/>
2. <http://www.edaboard.com/thread119480.html>
3. <http://www.dip.ee.uct.ac.za/~nicolls/lectures/eee482f/13_fsk_2up.pdf>
4. <http://dictionary.reference.com/browse/frequency+shift+keying>
5. <http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Frequency-shift_keying.html>

**Phase shift keying, Binary Phase shift keying transmitter and receiver** (Learning Aid & Methodology: Board activity & Presentation)

Phase shift keying, Binary Phase shift keying transmitter and receiver were discussed in board.

References:

1. <http://engineering.mq.edu.au/~cl/files_pdf/elec321/lect_mpsk.pdf>
2. <http://searchnetworking.techtarget.com/definition/phase-shift-keying>
3. <http://www.physics.udel.edu/~watson/scen103/projects/96s/thosguys/psk.html>
4. <http://www.radio-electronics.com/info/rf-technology-design/pm-phase-modulation/what-is-psk-phase-shift-keying-tutorial.php>
5. <http://www.dip.ee.uct.ac.za/~nicolls/lectures/eee482f/14_psk_2up.pdf>

**Conclusion & Summary** (Learning Aid & Methodology: Listing the keywords by students and consolidation)

The students were asked to recall and write the important technical key words of this session: Some of the keywords are: Frequency shift keying transmitter and receiver, Phase shift keying, Binary Phase shift keying transmitter and receiver.

**SESSION – 7**

**Recap: Frequency shift keying transmitter and receiver, Phase shift keying , Binary Phase shift keying transmitter and receiver** (Learning Aid & Methodology: Presentation Discussion)

Some questions were prepared by the faculty on the topics Frequency shift keying transmitter and receiver, Phase shift keying, Binary Phase shift keying transmitter and receiver.

1. What is Frequency shift keying?
2. What is Phase shift keying?
3. What is Binary Phase shift keying?

**Quadrature Phase Shift Keying Transmitter and Receiver** (Learning Aid & Methodology: Presentation)

The Quadrature Phase Shift Keying Transmitter and Receiver were discussed with the students by the faculty through board presentation.

References:

1. <http://turboblogsite.com/quadrature-phase-shift-keying-qpsk-modulation.html>
2. <http://iitg.vlab.co.in/?sub=59&brch=163&sim=1065&cnt=2404>
3. <http://www.maximintegrated.com/glossary/definitions.mvp/term/QPSK/gpk/244>

**Bandwidth consideration of QPSK** (Learning Aid & Methodology: Presentation)

The Bandwidth consideration of QPSK was discussed with the students by the faculty through board presentation.

References:

1. <http://ee.eng.usm.my/eeacad/mandeep/EEE436/CHAPTER2.pdf>
2. <http://uotechnology.edu.iq/dep-eee/lectures/4th/Electrical/Communication%20engineering%202/part2.pdf>
3. <http://descanso.jpl.nasa.gov/Monograph/series3/complete1.pdf>
4. <http://www.docstoc.com/docs/93552447/notes-in-phase-shift-keying-bpsk-qpsk>

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

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

The keywords are: Quadrature Phase Shift Keying Transmitter and Receiver, Bandwidth consideration of QPSK

**SESSION – 8**

**Recap: Quadrature Phase Shift Keying Transmitter and Receiver, Bandwidth consideration of QPSK**: (Learning Aid & Methodology: Presentation Discussion)

The faculty can begin the session by conducting a slide presentation so as to give a view on Quadrature Phase Shift Keying Transmitter and Receiver, Bandwidth consideration of QPSK.

**Quadrature Amplitude Modulation Transmitter and Receiver:** (Learning Aid & Methodology: Demonstration)

The Quadrature Amplitude Modulation Transmitter and Receiver were discussed with the students by the faculty through board presentation.

References:

1. www.ele.uri.edu/Courses/ele436/labs/QAM.pdf‎
2. <http://www.cascaderange.org/presentations/QPSK_and_16-QAM_Digital_Modulation.pdf>
3. <http://www.steepestascent.com/content/mediaassets/pdf/example%2016qam.pdf>

**Bandwidth consideration of QAM:** (Learning Aid & Methodology: Presentation)

The Bandwidth consideration of QAM were discussed with the students by the faculty through board presentation.

References:

1. www.ele.uri.edu/Courses/ele436/labs/QAM.pdf‎
2. <http://www.cascaderange.org/presentations/QPSK_and_16-QAM_Digital_Modulation.pdf>
3. <http://www.steepestascent.com/content/mediaassets/pdf/example%2016qam.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: *QAM, Quadrature, Constellation diagram, Phase diagram, Applications, QPSK, Number of Outputs, Name of Input, dibit, 900 Phase shifter, LPF.*

**SESSION – 9**

**Recap: Quadrature Amplitude Modulation Transmitter and Receiver, Bandwidth consideration of QAM** (Learning Aid & Methodology: Presentation Discussion)

The faculty can begin the session by conducting a slide presentation so as to give a view on Quadrature Amplitude Modulation Transmitter and Receiver, Bandwidth consideration of QAM

**Minimum shift keying transmitter and receiver** (Learning Aid & Methodology: Presentation)

The Minimum shift keying transmitter and receiver was discussed with the students by the faculty through board presentation.

References:

1. <http://www.dsplog.com/2009/06/16/msk-transmitter-receiver/>
2. <http://www.digitalsignallabs.com/msk.pdf>
3. <http://wlclab.hufs.ac.kr/images/4/42/QMSK.pdf>
4. <http://staff.neu.edu.tr/~fahri/mobile_L7.pdf>

**Gaussian minimum shift keying transmitter and receiver** (Learning Aid & Methodology: Presentation)

The Gaussian minimum shift keying transmitter and receiver was discussed with the students by the faculty through board presentation.

References:

1. <http://staff.neu.edu.tr/~fahri/mobile_L7.pdf>
2. <http://opendv.berlios.de/gmskrepeater.html>
3. <http://users.utcluj.ro/~dtl/TD/Cursuri/GMSK_12_13_P1_eng.pdf>
4. <http://sss-mag.com/pdf/gmsk_tut.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: MSK, Advantages of MSK, Special features of MSK, GMSK, Applications of GMSK, Special features in GMSK, GMSK bandwidth.