UNIT - I

CHAPTER 1: Introduction to Communication
CHAPTER 2: Amplitude Modulation (AM)
CHAPTER 3: DSB-SC & SSB-SC
CHAPTER 4: AM Demodulation and Super Heterodyne Receiver
CHAPTER 5: VSB & Hilbert Transform
CHAPTER 6: Angle Modulation (PM & FM)

UNIT - II

CHAPTER 7: Review of Random Variables
CHAPTER 8: Review of Random Processes
CHAPTER 9: Noise in AM and FM Systems
CHAPTER 10: Threshold Effect
CHAPTER 11: Low Pass Sampling and Quantization

UNIT – III

CHAPTER 12: Pulse Modulation (PM)
CHAPTER 13: Digital Techniques
CHAPTER 14: Error Control Codes

UNIT – IV

CHAPTER 15: Digital Modulation Scheme 1
CHAPTER 16: Digital Modulation Scheme 2
CHAPTER 17: Spectrum Analysis

UNIT – V

CHAPTER 18: Demodulation Techniques

Contents

Unit I: Amplitude Modulation

CHAPTER 1: INTRODUCTION TO COMMUNICATION		1.1 - 1.24
1.1	**Introduction**	**1**
	1.1.1 What is Communication?	1.1
	1.1.2 Basic Types of Communications Systems	1.2
1.2	**General Communication System**	**1.2**
1.3	**Main Classification of Signals**	**1.6**
1.4	**Frequency and Wavelength**	**1.8**
	1.4.1 Frequency (F)	1.8
	1.4.2 Wavelength (λ)	1.8
1.5	**Bandwidth (BW)**	**1.9**
1.6	**Baseband and Passband (or) Bandpass Communication**	**1.10**
	1.6.1 Drawbacks of Baseband (Without Modulation) Communication	1.10
1.7	**Modulation (Frequency Translation)**	**1.10**
	1.7.1 Why Modulation Needed?	1.10
	1.7.2 Modulation Process	1.11
1.8	**Advantages of Modulation Process**	**1.13**
1.9	**Classifications (or) Types of Modulation Techniques**	**1.17**
1.10	**Radio Frequency (RF) Spectrum**	**1.18**
1.11	***Solved Problems***	**1.20**
1.12	***Possible Two Marks Questions & Answers***	**1.21**
1.13	***Review Questions***	**1.24**

CHAPTER 2: AMPLITUDE MODULATION (AM)		2.1 - 2.49
2.1	**Introduction**	**2.1**
2.2	**Mathematical Representation of an AM Wave**	**2.1**
	2.2.1 Time Domain Representation of an AM Wave	2.2

	2.2.2 Frequency Domain Representation of AM (AM Voltage Distribution)	2.5
2.3	**Sidebands and Bandwidth of AM**	**2.6**
	2.3.1 Sidebands	2.6
	2.3.2 Bandwidth of AM	2.6
2.4	**Phasor (Vector) Representation of an AM Wave**	**2.7**
2.5	**Modulation Index of an AM**	**2.8**
	2.5.1 Coefficient of Modulation (or) Modulation Index	2.8
	2.5.2 Percentage Modulation	2.8
	2.5.3 Calculation of Modulation Index from AM Waveform	2.9
	2.5.4 Modulation Index for Multiple Modulating Signal	2.10
2.6	**AM Spectra [or] Spectrum of AM Signal**	**2.11**
2.6	**Power Relations (Distributions) in AM Wave**	**2.14**
	2.6.1 Introduction	2.14
	2.6.2 Carrier Power (P_c)	2.14
	2.6.3 Power in the Sidebands	2.15
	2.6.4 Total Power in AM Wave	2.16
	2.6.5 Modulation Index in terms of P_t And P_c	2.17
	2.6.6 Current Calculations	2.17
	2.6.7 Modulation Index in terms of Current	2.18
2.7	**Transmission (or) Modulation Efficiency**	**2.18**
2.8	**Advantages, Disadvantages and Applications of AM**	**2.20**
2.9	**Generation of AM Waves (AM Modulators)**	**2.20**
	2.9.1 Types of AM Modulators	2.20
2.10	**Generation of AM Waves Using Non-Linear Property**	**2.21**
2.11	**Square Law Modulator (Power-Law Modulator)**	**2.21**
2.12	**Switching Modulator**	**2.24**
2.13	***Solved Problems***	**2.27**
2.14	***Possible Two Marks Questions and Answers***	**2.44**
2.15	***Review Questions***	**2.49**

CHAPTER 3: DSB-SC & SSB-SC		3.1 - 3.31
3.1	**Introduction**	**3.1**
3.2	**Double Side Band–Suppressed Carrier (DSB-SC)**	**3.2**
	3.2.1 Time Domain Representation of DSB-SC	3.2
3.3	**Power Calculation of DSB-SC**	**3.4**
3.4	**Generation of DSB-SC-Wave**	**3.6**
	3.4.1 Balanced Modulator (BM)	3.6
	3.4.2 Balanced Ring Modulator (or) Double Balanced Modulator	3.8
3.5	**Advantages and Disadvantages of DSB-SC**	**3.12**
3.6	**Single Sideband Suppressed Carrier (SSB-SC)**	**3.13**
	3.6.1 Introduction	3.13
	3.6.2 Time Domain Representation of SSB-SC-AM	3.13
3.7	**Power Calculation in SSB-SC**	**3.15**
3.8	**Generation of SSB**	**3.16**
	3.8.1 Introduction	3.16
	3.8.2 Frequency Discrimination (or) Filter Method	3.17
	3.8.3 Phase Shift (or) Phasing Method	3.18
	3.8.4 Modified Phase Shift Method (or) Weaver's Method (or) The "Third" Method	3.21
	3.8.5 Advantages, Disadvantages and Applications of SSB-SC	3.25
3.9	***Solved Problems***	**3.26**
3.10	***Two Marks Questions and Answers***	**3.26**
3.11	***Review Questions***	**3.31**

CHAPTER 4: AM DEMODULATION AND SUPER HETERODYNE RECEIVER		4.1 - 4.39
4.1	**Introduction**	**4.1**
	4.1.1 Types of AM Detectors	4.1
4.2	**Synchronous (or) Coherent Detectors**	**4.2**
	4.2.1 Introduction	4.2
	4.2.2 DSB-SC	4.3
	4.2.3 SSB-SC	4.5

4.3	**Envelope Detector (Diode Detector)**	**4.7**
	4.3.1 Introduction	4.7
	4.3.2 Working Operation of Envelope Detector	4.8
	4.3.3 Distortions in the Envelope Detector Output: [Envelope Distortions]	4.9
	4.3.4 Necessary Conditions to Avoid Distortions: Selection of the RC Time Constant	4.11
4.4	**Square-Law Detectors**	**4.13**
	4.4.1 Introduction	4.13
	4.4.2 Operation	4.14
4.5	**Super Heterodyne Receiver**	**4.15**
	4.5.1 Introduction	4.15
	4.5.2 Functions of the Receiver	4.16
	4.5.3 Radio Receiver Parameters	4.16
4.6	**Classification of Radio Receivers**	**4.17**
	4.6.1 Introduction	4.17
	4.6.2 Types of Non-coherent Radio Receivers	4.17
4.7	**Tuned Radio Frequency (TRF) Receiver**	**4.18**
	4.7.1 Introduction	4.18
	4.7.2 Working Operations	4.18
	4.7.3 Advantages and Disadvantages of TRF Receivers	4.20
4.8	**AM Super Heterodyne Receiver**	**4.20**
	4.8.1 Introduction: How to overcome the TRF receiver Drawbacks	4.20
	4.8.2 General Blocks	4.22
4.9	**FM Super Heterodyne Receiver**	**4.26**
	4.9.1 Advantages of Super Heterodyne Receiver over TRF Receiver	4.27
4.10	***Solved Problems***	**4.27**
4.11	***Possible Two Marks Questions and Answers***	**4.30**
4.12	***Review Questions***	**4.38**

CHAPTER 5: VSB & HILBERT TRANSFORM		5.1 - 5.23
5.1	**Vestigial Sideband (VSB) Modulation**	**5.1**
	5.1.1 Why VSB is Used in Picture Signals?	5.1
	5.1.2 Generation of VSB (Filter Method)	5.2
	5.1.3 VSB Demodulator	5.3
	5.1.4 Representation of VSB	5.4
	5.1.5 Frequency (Magnitude) Response of VSB Filter [or] VSB Filter Characteristics	5.5
	5.1.6 Transmission Bandwidth of VSB	5.6
	5.1.7 Advantages and Application of VSB	5.6
5.2	**Comparison of Different Amplitude Modulation Systems**	**5.7**
5.3	**Hilbert Transform**	**5.8**
	5.3.1 Introduction	5.8
	5.3.2 Characteristics	5.9
	5.3.3 Properties of the Hilbert Transform	5.12
	5.3.4 Applications	5.12
5.4	**Pre-Envelope (or) Analytic Signal**	**5.13**
	5.4.1 Introduction	5.13
	5.4.2 Positive Frequencies	5.13
	5.4.3 Negative Frequencies	5.14
5.5	**Complex Envelope**	**5.15**
5.6	***Solved Problems***	**5.16**
5.7	***Two Marks Questions and Answers***	**5.19**
5.8	***Review Questions***	**5.23**

CHAPTER 6: ANGLE MODULATION (PM & FM)		6.1 - 6.58
6.1	**Introduction**	**6.1**
	6.1.1 Classification of Angle Modulation	6.1
6.2	**Phase Modulation (PM)**	**6.2**
	6.2.1 Representation of PM Signal	6.2
	6.2.2 PM Waveforms	6.4

6.3	**Frequency Modulation (FM)**	**6.5**
	6.3.1 Introduction	6.5
	6.3.2 Representation of FM Signal (or) Mathematical Expression for Single-tone FM Signal	6.5
	6.3.3 FM Waveforms	6.7
	6.3.4 Frequency Deviation (Δf)	6.8
	6.3.5 Modulation index of FM	6.8
	6.3.6 Deviation Ratio (DR)	6.9
	6.3.7 Percentage Modulation of FM	6.10
6.4	**Frequency Analysis of the FM Wave (or) Spectrum of the FM Wave (or) Spectra of FM Signal (or) Spectral Characteristics of Angle-Modulated Signals**	**6.10**
	6.4.1 Introduction	6.10
	6.4.2 Modulation by a Single-tone Frequency Signal	6.11
	6.4.3 Average Power (or) Power Relations in Sinusoidal FM	6.15
	6.4.4 Effect of Modulation Index	6.16
6.5	**Transmission Bandwidth of FM**	**6.18**
	6.5.1 Introduction	6.18
	6.5.2 Bandwidth of Wideband FM	6.19
	6.5.3 Carson's Rule	6.19
6.6	**Types of Frequency Modulation**	**6.21**
	6.6.1 Introduction	6.21
	6.6.2 NarrowBand FM (NBFM)	6.21
	6.6.3 WideBand FM (WBFM)	6.23
	6.6.4 Comparison of WideBand FM and NarrowBand FM	6.26
6.7	**Comparisons**	**6.28**
	6.7.1 Comparison of FM and PM	6.28
	6.7.2 Comparison of FM and AM	6.29
6.8	**Advantages, Disadvantages and Applications of FM**	**6.31**
6.9	***Solved Problems***	**6.32**
6.10	***Two Marks Questions and Answers***	**6.48**
6.11	***Review Questions***	**6.58**

Unit II: Random Process & Sampling

CHAPTER 7: REVIEW OF RANDOM VARIABLES		7.1 - 7.31
7.1	**Introduction**	7.1
7.2	**Review of Probability Theory**	7.1
	7.2.1 Introduction	7.1
	7.2.2 Properties of Probability	7.3
	7.2.3 Conditional Probability	7.4
	7.2.4 Statistically Independent Events	7.5
	7.2.5 Baye's Theorem	7.5
7.3	**Random Variables**	7.5
	7.3.1 Introduction	7.5
	7.3.2 Probability Distribution Functions (or) Probability Function	7.7
	7.3.3 Two (or) Multiple Random Variables	7.10
	7.3.3 Important Random Variables	7.12
	7.3.4 Statistical Averages of Random Variables	7.17
7.4	***Solved Problems***	7.19
7.5	***Possible Two Marks Questions and Answers***	7.25
7.6	***Review Questions***	7.31

CHAPTER 8: REVIEW OF RANDOM PROCESSES		8.1 - 8.30
8.1	**Introduction**	8.1
	8.1.1 Sample Function	8.1
8.2	**Stationary process**	8.3
	8.2.1 Introduction	8.3
	8.2.2 Strict-Sense Stationary (SSS)	8.3
	8.2.3 Wide Sense Stationary Process	8.4
8.3	**Mean, Correlation and Covariance Functions [Or] Statistical Averages [Or] Ensemble Averages**	8.5
	8.3.1 Mean	8.5
	8.3.2 Correlation	8.5
	8.3.3 Covariance	8.7

8.4	**Gaussian Process**	**8.8**
	8.4.1 Introduction	8.8
	8.4.2 Central Limit Theorem (CLT)	8.10
	8.4.3 Properties of Gaussian Process	8.11
8.5	**White Noise**	**8.13**
8.6	***Solved Problems***	**8.14**
8.7	***Two Marks Questions and Answers***	**8.24**
8.8	***Review Questions***	**8.30**

CHAPTER 9: NOISE IN AM AND FM SYSTEMS ***9.1 - 9.31***

9.1	**Introduction**	**9.1**
	9.1.1 Receiver Model	9.1
	9.1.2 Figure of Merit (γ)	9.2
	9.1.3 Channel Noise is Additive	9.2
	9.1.4 Channel Noise is White and Gaussian	9.3
	9.1.5 Band Pass Filter (BPF) at the Input of Detector	9.3
9.2	**Some Important Definitions**	**9.4**
9.3	**Effect of Noise on a Baseband System**	**9.5**
9.4	**Noise in DSB-SC Linear Receiver System using Coherent Detection (Or) Effect of Noise on DSB-SC-AM**	**9.6**
	9.4.1 Introduction	9.6
	9.4.2 Channel Signal-to-Noise Ratio	9.7
	9.4.3 DSB-SC Filtered Signal	9.8
	9.4.4 Product Modulator Output Signal	9.8
	9.4.5 LPF Output Signal	9.9
	9.4.6 Output Signal-to-Noise Ratio	9.10
	9.4.7 Figure of Merit (γ)	9.11
9.5	**Noise in AM Receivers using Envelope Detection (or) Effect of Noise on Conventional AM**	**9.11**
	9.5.1 Introduction	9.11
	9.5.2 Channel Signal-to-Noise Ratio	9.12
	9.5.3 Filtered Signal	9.13

	9.5.4 Receiver Output Signal	9.13
	9.5.5 Output Signal-to-Noise Ratio	9.14
	9.5.6 Figure of Merit (γ)	9.15
9.6	**Noise in FM Receivers (or) Effect of Noise on Angle Modulation**	**9.16**
	9.6.1 Introduction	9.16
	9.6.2 Working Operation	9.16
	9.6.3 Filtered Signal	9.18
	9.6.4 Discriminator Output	9.19
	9.6.5 Output Signal-to-Noise Ratio	9.19
	9.6.6 Channel Signal-to-Noise Ratio	9.21
	9.6.7 Figure of Merit	9.21
	9.6.8 Figure of Merit in Terms of Modulation Index of FM	9.22
9.7	**Comparison of Performance**	**9.23**
9.8	***Solved Problems***	**9.24**
9.9	***Possible Two Marks Questions and Answers***	**9.28**
9.10	***Review Questions***	**9.31**
CHAPTER 10: THRESHOLD EFFECT		*10.1 - 10.22*
10.1	**FM Threshold Effect**	**10.1**
	10.1.1 Introduction	10.1
	10.2.2 Baseband Threshold in FM	10.3
10.2	**FM Threshold Reduction Methods**	**10.6**
10.3	**Pre-Emphasis and De-Emphasis**	**10.7**
	10.3.1 Introduction	10.7
	10.3.2 Pre-Emphasis	10.8
	10.3.3 De-Emphasis	10.8
	10.3.4 Improvement Factor (I)	10.10
10.4	**FMFB Demodulator**	**10.12**
	10.4.1 Introduction	10.12
	10.4.2 Working Operations	10.12
10.5	***Solved Problems***	**10.14**
10.6	***Possible Two Marks Questions and Answers***	**10.19**
10.7	***Review Questions***	**10.22**

	9.5.4 Receiver Output Signal	9.13
	9.5.5 Output Signal-to-Noise Ratio	9.14
	9.5.6 Figure of Merit (γ)	9.15
9.6	**Noise in FM Receivers (or) Effect of Noise on Angle Modulation**	**9.16**
	9.6.1 Introduction	9.16
	9.6.2 Working Operation	9.16
	9.6.3 Filtered Signal	9.18
	9.6.4 Discriminator Output	9.19
	9.6.5 Output Signal-to-Noise Ratio	9.19
	9.6.6 Channel Signal-to-Noise Ratio	9.21
	9.6.7 Figure of Merit	9.21
	9.6.8 Figure of Merit in Terms of Modulation Index of FM	9.22
9.7	**Comparison of Performance**	**9.23**
9.8	***Solved Problems***	**9.24**
9.9	***Possible Two Marks Questions and Answers***	**9.28**
9.10	***Review Questions***	**9.31**
CHAPTER 10: THRESHOLD EFFECT		*10.1 - 10.22*
10.1	**FM Threshold Effect**	**10.1**
	10.1.1 Introduction	10.1
	10.2.2 Baseband Threshold in FM	10.3
10.2	**FM Threshold Reduction Methods**	**10.6**
10.3	**Pre-Emphasis and De-Emphasis**	**10.7**
	10.3.1 Introduction	10.7
	10.3.2 Pre-Emphasis	10.8
	10.3.3 De-Emphasis	10.8
	10.3.4 Improvement Factor (I)	10.10
10.4	**FMFB Demodulator**	**10.12**
	10.4.1 Introduction	10.12
	10.4.2 Working Operations	10.12
10.5	***Solved Problems***	**10.14**
10.6	***Possible Two Marks Questions and Answers***	**10.19**
10.7	***Review Questions***	**10.22**

CHAPTER 11: LOW PASS SAMPLING AND QUANTIZATION 11.1 - 11.44

11.1 ADC Converter **11.1**
11.2 Sampling Process **11.1**
11.3 Low Pass Sampling [Or] Sampling of Signals and Signal Reconstruction from Samples **11.3**
11.3.1 Statement of Sampling Theorem 11.3
11.3.2 Definition 11.4
11.3.3 Proof of Sampling Theorem 11.4
11.4 Nyquist Criterion: Nyquist Rate and Nyquist Interval **11.12**
11.5 Aliasing (Or) Foldover Error (Or) Effects of Undersampling **11.13**
11.5.1 Introduction 11.13
11.5.2 Elimination of Aliasing 11.14
11.6 Quantization Process **11.15**
11.6.1 Introduction 11.15
11.6.2 Types of Quantization Process 11.17
11.6.3 Uniform Quantizer (Linear Quantizer) 11.17
11.6.4 Non-Uniform Quantizer 11.22
11.7 Companding **11.25**
11.7.1 Why Companding? 11.25
11.7.2 Introduction 11.25
11.7.3 Compander Characteristics 11.26
11.7.4 Different Methods of Companding (or) Logarithmic Companding 11.28
11.7.5 Signal to Noise Ratio (SNR) of Companded PCM 11.31
11.8 Quantization Noise (Or) Error [Or] Signal to Noise Ratio in PCM (Uniform Quantizer) **11.31**
11.8.1 Derivation of Quantization Error/ Noise (or) Noise Power for Uniform (linear) Quantizer 11.31
11.8.2 Derivation of Maximum Signal-to-Quantization Noise Ratio for Linear Quantization 11.34
11.9 *Solved Problems* **11.36**
11.10 *Two Marks Questions and Answers* **11.39**
11.11 *Review Questions* **11.44**

Unit III: Digital Techniques

CHAPTER 12: PULSE MODULATION (PM) 12.1 - 12.49

12.1 Introduction **12.1**
12.1.1 Classifications of Pulse Modulation 12.1
12.2 Pulse Amplitude Modulation (PAM) **12.3**
12.2.1 Introduction 12.3
12.2.2 Natural PAM 12.3
12.2.3 Flat Top PAM 12.6
12.2.4 Transmission Bandwidth of PAM Signal 12.8
12.2.5 Advantages and Disadvantages of PAM 12.9
12.3 Pulse Time Modulation (PTM) **12.9**
12.4 Pulse Width Modulation (PWM) **12.10**
12.4.1 Introduction 12.10
12.4.2 PWM Signal Generation 12.11
12.4.3 PWM Signal Detection 12.12
12.4.4 Advantages and Disadvantages of PWM 12.13
12.5 Pulse Position Modulation (PPM) **12.14**
12.5.1 PPM Signal Generation 12.14
12.5.2 PPM Signal Demodulation 12.15
12.5.3 Advantages and Disadvantages of PPM 12.16
12.5.4 Transmission Bandwidth of PWM and PPM 12.16
12.6 Comparison of PAM, PWM and PPM Systems **12.17**
12.7 Pulse Code Modulation (PCM) **12.18**
12.7.1 Introduction 12.18
12.7.2 PCM System 12.18
12.7.3 PCM Transmitter 12.19
12.7.4 PCM Transmission Path 12.20
12.7.5 PCM Receiver 12.22
12.7.6 Signal to Quantization Noise Ratio (SNR) of PCM 12.23

12.7.7	Signaling Rate and Transmission Bandwidth of PCM	12.23
12.7.8	Advantages, Disadvantages And Applications of PCM	12.24
12.8	**Comparison between PAM, PWM, PPM and PCM**	**12.25**
12.9	**Time Division Multiplexing (TDM)**	**12.27**
12.9.1	Introduction	12.27
12.9.2	Working Operations of TDM	12.27
12.9.3	Types of TDM	12.29
12.9.4	Transmission Hierarchy (T- Carrier Systems)	12.32
12.9.5	Advantages and Disadvantages of TDM	12.34
12.10	**Frequency Division Multiplexing (FDM)**	**12.34**
12.10.1	Introduction	12.34
12.10 2	Operation of FDM Systems	12.36
12.10.3	Advantages, Disadvantages and Applications of FDM	12.37
12.10.4	Difference between FDM and TDM	12.38
12.11	***Solved Problems***	**12.39**
12.12	***Two Marks Questions and Answers***	**12.42**
12.13	***Review Questions***	**12.48**

CHAPTER 13: DIGITAL TECHNIQUES *13.1 - 13.23*

13.1	**Differential Pulse Code Modulation (DPCM)**	**13.1**
13.1.1	Why DPCM?	13.1
13.2	**DPCM System**	**13.1**
13.2.1	DPCM Transmitter	13.1
13.2.2	DPCM Receiver	13.3
13.2.3	Advantages and Disadvantages	13.4
13.3	**Delta Modulation (DM)**	**13.4**
13.3.1	Why DM?	13.4
13.3.2	DM Transmitter	13.5
13.3.3	DM Receiver	13.7
13.3.4	Quantization Noise (Distortions) in DM System	13.8
13.3.5	DM Bit Rate (Signaling Rate)	13.9
13.3.6	Advantages and Disadvantages of DM	13.10

13.4	**Comparison of Digital Pulse Modulation Systems**	**13.10**
13.5	**Noise Considerations in PCM**	**13.11**
	13.5.1 Introduction	13.11
	13.5.2 Error Threshold	13.13
13.6	**Digital Multiplexers**	**13.15**
	13.6.1 Introduction	13.15
	13.6.2 Types	13.15
	13.6.3 TDM Hierarchy	13.16
	13.6.4 T Carrier System	13.17
13.7	***Two Marks Questions and Answers***	**13.20**
13.8	***Review Questions***	**13.22**

CHAPTER 14: ERROR CONTROL CODES ***14.1 - 14.49***

14.1	**Shannon's Theorems**	**14.1**
14.2	**Channel - Coding Theorem**	**14.1**
	14.2.1 Need for Channel Coding	14.1
	14.2.2 Channel Coding Process	14.2
	14.2.3 Code Rate	14.3
	14.2.4 Discrete Memeoryless Source (DMS)	14.3
	14.2.5 Discrete Memoryless Channel (DMC)	14.3
	14.2.6 Statement	14.4
	14.2.7 Application of the Channel Coding Theorem to Binary Symmetric Channels	14.5
14.3	**Error-Control Coding**	**14.6**
	14.3.1 Introduction	14.6
	14.3.2 Hamming Distance	14.7
14.4	**Linear Block Codes**	**14.8**
	14.4.1 Introduction	14.8
	14.4.2 Matrix Description of Linear Block Codes	14.10
14.5	**Hamming Codes**	**14.12**
	14.5.1 Error Detection and Correction Capabilities of Hamming Codes	14.12
	14.5.2 Encoder of (7, 4) Hamming Code	14.13

14.6	**Syndrome Calculation**	**14.14**
	14.6.1 Syndrome Decoding	14.14
14.7	**Cyclic Codes**	**14.15**
	14.7.1 Properties of Cyclic Codes	14.16
	14.7.2 Algebraic Structures of Cyclic Codes (Code Word Polynomial)	14.17
	14.7.3 Generations of Non-Systematic Code Vectors (or) Generator Polynomial for the Cyclic Code	14.18
	14.7.4 Generation of Systematic Code Vectors	14.21
	14.7.5 Encoder for Cyclic Codes	14.24
	14.7.6 Advantages and Disadvantages of Cyclic Codes	14.26
14.8	**Convolutional Codes**	**14.27**
	14.8.1 Convolutional Encoder	14.27
	14.8.2 Advantages and Disadvantages	14.29
14.9	**Viterbi Algorithm (Or) Viterbi Decoder**	**14.29**
	14.9.1 Introduction	14.29
	14.9.2 Steps Followed in Construction of Viterbi Algorithm	14.29
	14.9.3 Example	14.30
14.10	***Solved Problems***	**14.35**
14.11	***Two Marks Questions and Answers***	**14.42**
14.12	***Review Questions***	**14.49**

Unit IV: Digital Modulation Scheme

CHAPTER 15: DIGITAL MODULATION SCHEME 1 *15.1 - 15.23*

15.1	**Introduction**	**15.1**
	15.1.1 Classifications of Digital Signal Transmission	15.1
	15.1.2 Classification of Digital Modulation Detection Techniques	15.2
	15.1.3 Advantages and Disadvantages of Digital Communication System	15.3

15.2	**Geometric Representation of Signals**	**15.3**
15.2.1	Introduction	15.3
15.2.2	Relation between the Vector Representation of a Signal and its Energy Value	15.6
15.2.3	Euclidean Distance	15.7
15.3	**Binary Frequency Shift Keying (BFSK)**	**15.8**
15.3.1	Introduction	15.8
15.3.2	Generation of Coherent Binary FSK	15.8
15.3.3	FSK Waveforms	15.10
15.3.4	Baud Rate and Bandwidth	15.11
15.3.5	FSK Non-Coherent Receiver	15.12
15.3.6	Coherent FSK Receiver	15.13
15.3.7	Geometrical (or) Signal Space Representation of Orthogonal BFSK	15.14
15.3.8	Power Spectral Density (PSD) of BFSK Signals	15.16
15.3.9	Probability of Error (or) Error Probability (or) Bit Error Rate (BER) of BFSK	15.17
15.3.10	Advantages, Disadvantages and Application	15.19
15.4	***Solved Problem***	**15.19**
15.5	***Two Marks Questions and Answers***	**15.20**
15.6	***Review Questions***	**15.23**

CHAPTER 16: DIGITAL MODULATION SCHEME 2 ***16.1 - 16.36***

16.1	**Binary Phase Shift Keying (BPSK)**	**16.1**
16.1.1	Introduction	16.1
16.1.2	Representation of BPSK	16.1
16.1.3	BPSK Generation	16.2
16.1.4	Graphical Representation of BPSK Signal	16.3
16.1.5	BPSK Detection (Or) Coherent BPSK Receiver	16.3
16.1.6	Geometrical Representation (Or) Signal Space Diagram	16.4
16.1.7	Power Spectral Density (PSD) of BPSK	16.5

16.1.8	Error Probability of BPSK	16.6
16.1.9	Bandwidth of BPSK	16.8
16.1.10	Advantages, Disadvantages and Applications	16.8
16.2	**Comparison of Binary Modulation Systems**	**16.9**
16.3	**Quadrature Phase Shift Keying (QPSK)**	**16.10**
16.3.1	Introduction	16.10
16.3.2	QPSK Coherent Generation (or) Transmitter	16.11
16.3.3	QPSK Coherent Detection	16.12
16.3.4	Signal–Space Diagram of QPSK	16.13
16.3.5	Power Spectral Density (PSD) of QPSK Signal	16.15
16.3.6	Error Probability of QPSK	16.17
16.3.7	Bandwidth of QPSK	16.20
16.3.8	Advantages and Disadvantages	16.21
16.3.9	Comparison Between BPSK and QPSK	16.21
16.4	**Quadrature Amplitude Modulation (QAM)**	**16.22**
16.4.1	Introduction	16.22
16.4.2	Geometrical (or) Signal Space Representation	16.23
16.4.3	QAM Coherent Transmitter	16.24
16.4.4	QAM Coherent Receiver	16.26
16.4.5	Power Spectral Density of QAM Signal	16.26
16.4.6	Bandwidth of QAM Signal	16.27
16.4.7	Probability of Error for M-ary QAM	16.27
16.4.8	Advantages and Disadvantages	16.27
16.4.9	Comparison between QPSK and QAM	16.28
16.5	**Comparisons of Digital Modulation Techniques**	**16.29**
16.6	***Solved Problems***	**16.30**
16.7	***Two Marks Questions and Answers***	**16.32**
16.8	***Review Questions***	**16.35**

CHAPTER 17: SPECTRUM ANALYSIS 17.1 - 17.21

17.1 **Synchronization** 17.1
17.1.1 Introduction 17.1
17.1.2 Squaring Loop 17.2
17.1.3 Costas Loop 17.3
17.1.4 Remodulator 17.4
17.1.5 Clock Recovery (or) Clock Synchronization 17.5
17.2 **Spectrum Analysis (SA)** 17.6
17.2.1 Introduction 17.6
17.2.2 Occupied BandWidth (OBW) 17.7
17.2.3 Adjacent Channel Power (ACP) 17.8
17.3 **Error Vector Magnitude (EVM)** 17.10
17.4 **Differential Phase Shift Kcying (DPSK)** 17.13
17.4.1 Introduction 17.13
17.4.2 DPSK Transmitter 17.13
17.4.3 DPSK Waveforms 17.15
17.4.4 DPSK Receiver 17.15
17.4.5 Error Probability of DPSK 17.18
17.4.6 Bandwidth of DPSK 17.18
17.4.7 Advantages and Disadvantages 17.18
17.5 *Two Marks Questions and Answers* 17.19
17.6 *Review Questions* 17.21

Unit V: Demodulation Techniques

CHAPTER 18: DEMODULATION TECHNIQUES 18.1 - 18.41

18.1 **Elements of Detection Theory** 18.1
18.1.1 Concept of Detection 18.1
18.1.2 Likelihood Functions 18.3
18.2 **Coherent Detection of Signals in Noise (or) Optimum Receivers Using Coherent Detection (or) Optimum Detection of Signals in Noise (or) Maximum Likelihood Decoding** 18.4
18.2.1 Introduction 18.4

	18.2.2 Signal Detection Problem	18.6
	18.2.3 Graphical Interpretation	18.8
18.3	**Coherent Communication with Waveforms (or) Correlation Receiver (or) Optimum Receiver**	**18.10**
	18.3.1 Introduction	18.10
	18.3.2 Matched Filter Receiver	18.12
18.4	**Baseband Pulse Transmission**	**18.14**
	18.4.1 Matched Filter Detection	18.14
	18.4.1 Properties of Matched Filters	18.17
18.5	**Probability of Error due to Noise (or) Probability of Error Evaluations (or) Error Rate due to Noise**	**18.18**
	18.5.1 Introduction	18.18
	18.5.2 Symbol '0' Transmitted	18.19
	18.5.3 Symbol '1' Transmitted	18.21
18.6	**Intersymbol Interference (ISI)**	**18.23**
	18.6.1 Introduction	18.23
	18.6.2 Baseband Binary Data PAM System	18.24
18.7	**Optimum Demodulaion of Digital Signals Over Band-Limited Channels (Or) Nyquist's Criterion for Distortionless Baseband Binary Transmission**	**18.27**
	18.7.1 Nyquist Criterion for Zero ISI	18.27
	18.7.2 Ideal Nyquist Channel	18.30
	18.7.3 Raised Cosine Filters (or) Raised Cosine Spectrum	18.32
18.8	***Solved Problem***	**18.35**
18.9	***Two Marks Questions and Answers***	**18.36**
18.10	***Review Questions***	**18.40**

SOLVED MODEL QUESTION PAPERS

❑❑