**SRM Institute of Science and Technology**

**Batch 1**

**Set A**

**College of Engineering and Technology**

**DEPARTMENT OF ECE**

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamilnadu

**Academic Year: 2024-2025 (Even)**

**Test: FT- III** **Date: 03.04.2025**

**Course Code / Title:21ECC302T/ Analog and Digital Communication-Answer Key Duration:08.00 – 9.40 AM**

**Year & Sem:III&VI** **Max. Marks:50**

**Course Articulation Matrix:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **21ECC302T/ Analog and Digital Communication** | **PROGRAM OUTCOMES (PO)** | | | | | | | | | | | | **PROGRAM SPECIFIC OUTCOMES** | | | |
| **S.NO** | **COURSE OUTCOMES** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| 1 | Explain the Various Analog Modulation Techniques | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | - | - |
| 2 | Analyze the Noise performance of Radio transmitters and Receivers | 3 | 3 | - | - | - | - | - | - | - | - | - | 2 | - | 3 | - |
| 3 | Demonstrate the demodulation and detection of received digital data | 3 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| 4 | Apply the suitable passband techniques for real time applications | 3 | - | - | - | 3 | - | - | - | - | - | - | - | - | - | 2 |
| 5 | Exposed to the concepts of information theory and channel capacity | 3 | - | 3 | - | - | - | - | - | - | - | - | - | 3 | - | - |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Part – A(11x1 = 11Marks)**  **Answer all the questions** | | | | |
| **Q. No** | **Question** | **Marks** | **BL** | **CO** |
|  | When the highest signal frequency is 10 KHz, the minimum sampling rate should be ------------ according to Nyquist rate  A) 5 KHz B) 10 KHz C) 20 KHz  D) 2 KHz | **1** | **1** | **3** |
|  | If number of quantization levels in a PCM system is 13, the number of bits for encoding required is  A) 13  B) 4 C) 3 D) 5 | **1** | **1** | **3** |
|  | In Delta modulation, when the inut signal is varying fast and and step size could not follow it closely,  A) Eye pattern reduces.  B) Inter Symbol Interference occurs  C) granular noise occurs  D) Slope overload distortion occurs | **1** | **1** | **3** |
|  | Nyquist rate is applied to  A) Analog Modulation  B) Digital Modulation  C) Pulse Modulation  D) Can’t say | **1** | **1** | **3** |
|  | DPCM is a modulation technique which uses  A) 1 bit only  B) 2 bits only  C) 3 bits only  D) Can’t Say | **1** | **1** | **3** |
|  | Delta Modulation involves A) Sampling B) Quantization  C) Step size variation D) All of the above | **1** | **2** | **4** |
|  | Relatively more noise occurs in  A) PCM  B) PPM C) PAM D) DM | **1** | **2** | **4** |
|  | Which of the following is bandwidth conserving modulation scheme  A) Amplitude Shift Keying  B) Frequency Shift Keying C) Binary Phase Shift Keying D) Quadriphase shift keying | **1** | **2** | **4** |
|  | Decision Device is a part of  A) Sampler  B) Digital Modulation Receiver  C) Digital Modulation Transmitter  D) Quantizer | **1** | **2** | **4** |
|  | AWGN refers to  A) Advanced White Gaussian Noise  B) Advanced White General Noise  C) Additive White Gaussian Noise  D) Additive White General Noise | **1** | **1** | **4** |
|  | Constellation diagram applies to  A) PCM  B) DM  C) BFSK  D) PPM | **1** | **2** | **4** |
| **Part – B (3 x 8 = 24Marks)** | | | | |
|  | | | | |
| **12(a)**  **12(b)** | Describe the generation and detection of PAM signals with necessary waveforms.  Generation     * The circuit is simple emitter follower., In the absence of the clock signal, the output follows input.The modulating signal is applied as the input signal. Another input to the base of the transistor is the clock signal. The frequency of the clock signal is made equal to the desired carrier pulse train frequency. * The amplitude of the clock signal is chosen the high level is at ground level(0v) and low level at some negative voltage sufficient to bring the transistor in cutoff region. * When clock is high, circuit operates as emitter follower and the output follows in the input modulating signal. When clock signal is low, transistor is cutoff and output is zero. Thus the output is the desired PAM signal. (4 Marks)   Demodulation    (2 Marks)  Waveforms (2 Marks)  Or  Explain different blocks and elements of digital communication system .    (3 Marks)  1. Information Source and Input Transducer:   * The source of information can be analog or digital, e.g. analog: audio or video signal, digital: like teletype signal. In digital communication the signal produced by this source is converted into digital signal which consists of 1′s and 0′s. For this we need a source encoder.   2. Source Encoder:   * In digital communication we convert the signal from source into digital signal as mentioned above. The point to remember is we should like to use as few binary digits as possible to represent the signal. In such a way this efficient representation of the source output results in little or no redundancy. This sequence of binary digits is called information sequence. * Source Encoding or Data Compression: the process of efficiently converting the output of whether analog   3. Channel Encoder:   * The information sequence is passed through the channel encoder. The purpose of the channel encoder is to introduce, in controlled manner, some redundancy in the binary information sequence that can be used at the receiver to overcome the effects of noise and interference encountered in the transmission on the signal through the channel. * For example take k bits of the information sequence and map that k bits to unique n bit sequence called code word. The amount of redundancy introduced is measured by the ratio n/k and the reciprocal of this ratio (k/n) is known as rate of code or code rate. * Digital Modulator: * The binary sequence is passed to digital modulator which in turns convert the sequence into electric signals so that we can transmit them on channel. The digital modulator maps the binary sequences into signal wave forms , for example if we represent 1 by sin x and 0 by cos x then we will transmit sin x for 1 and cos x for 0. ( a case similar to BPSK) * 5. Channel: * The communication channel is the physical medium that is used for transmitting signals from transmitter to receiver. In wireless system, this channel consists of atmosphere , for traditional telephony, this channel is wired , there are optical channels, under water acoustic channels etc.We further discriminate this channels on the basis of their property and characteristics, like AWGN channel etc. * 6. Digital Demodulator: * The digital demodulator processes the channel corrupted transmitted waveform and reduces the waveform to the sequence of numbers that represents estimates of the transmitted data symbols * Channel Decoder: * This sequence of numbers then passed through the channel decoder which attempts to reconstruct the original information sequence from the knowledge of the code used by the channel encoder and the redundancy contained in the received data Note: The average probability of a bit error at the output of the decoder is a measure of the performance of the demodulator – decoder combination. * 8. Source Decoder: * At the end, if an analog signal is desired then source decoder tries to decode the sequence from the knowledge of the encoding algorithm. And which results in the approximate replica of the input at the transmitter end. * 9. Output Transducer: * Finally we get the desired signal in desired format analog or digital. (5 Marks) | **8**  **8** | **2**  **2** | **3**  **3** |
| **13(a)**  **13(b).** | (i) Why do eye diagrams play important role in analyzing noise effects in digital transmission scheme.  An eye pattern provides a great deal of useful information about the performance of a data transmission system, as described in Figure 2. Specifically, we may make the following statements:   * The width of the eye opening defines the time interval over which the received signal can be sampled without error from intersymbol interference. It is apparent that the preferred time for sampling is the instant of time at which the eye is open the widest. * The sensitivity of the system to timing errors is determined by the rate of closure of the eye as the sampling time is varied. * The height of the eye opening, at a specified sampling time, defines the noise margin of the system. * When the effect of intersymbol interference is severe, traces from the upper portion of the eye pattern cross traces from the lower portion, with the result that the eye is completely closed. In such a situation, it is impossible to avoid errors due to the presence of intersymbol interference in the system. * In the case of an M-ary system, the eye pattern contains (M — 1) eye openings stacked up vertically one on the other, where M is the number of discrete amplitude levels used to construct the transmitted signal. In a strictly linear system with truly random data, all these eye openings would be identical. In practice, however, it is often possible to discern asymmetries in the eye pattern, which are caused by nonlinearities in the communication channel.   (4 Marks)  (ii) A base band signal **200 sin300.14t** is sampled exactly at Nyquist rate. If it has to be quantized at 256 levels, Find the sampling rate and no of bits required and resolution of the PCM.  Baseband frequency 50 Hz (1 Mark)  Sampling rate 100 Hz ( 1 Mark)  Number of bits required is 8 ( 1 Mark)  Buadrate is 800 bits/sec (1 Mark)  Or  (i) Compare base band and Pass band schemes.  **Baseband data transmission**   * Digital data is transmitted over the channel directly * No modulation is done * Suitable for transmission over short distance * Eg audio and Video signal (2 Marks)   **Pass band data transmission**   * Digital data transmitted using a high frequency carrier * Modulation is done * Suitable for transmission over long distances * ASK,FSK,PSK (2 Marks)   **Requirements of Pass band Transmission Scheme**   * Maximum Data transmission rate * Minimum Probability of symbol error * Minimum Transmitted power * Minimum Channel Bandwidth * Maximum resistance to interfering signals * Minimum circuit complexity (2 Marks)   **Advantages of Pass band Transmission over Baseband transmission**   * Long Distance Transmission * Analog Channels, can be used for Transmission * Multiplexing techniques can be used for BW conservation. * Problems such as ISI and crosstalk are absent * Pass band transmission can take place over wireless channels also. (2 Marks) | **4**  **4**  **8** | **3**  **3**  **3** | **3**  **3**  **4** |
| **14(a)**  **14(b)** | Explain PCM with supporting diagrams    (4 Marks)  When a digital signal undergoes Pulse Code Modulation, it converts the analog information into a binary sequence (1 and 0). Through the demodulation process, we can obtain the original analog signal. The figure below represents the output of the PCM signal with respect to the sine wave.  Pulse Code Modulation techniques are used to produce a series of numbers or digits in binary form. Hence this process is called digital modulation. The amplitude at that particular time of the signal sample is indicated by the binary codes.  In the PCM process, a sequence of coded pulses indicates the message signal. This message signal represents amplitude and time.  Pulse code modulations are of two types:   * Differential pulse code modulation (DPCM) * Adaptive differential pulse code modulation (ADPCM)   Differential pulse-code modulation is a signal encoding process which adds functionalities based on the prediction of the samples of the signal.  Adaptive differential pulse-code modulation is a technique in which the size of the quantization step is varied, to allow the further reduction of the required data bandwidth to a given signal-to-noise ratio.  The Pulse Code Modulation process is done through the following steps:  Sampling  Quantisation  Coding  (4 Marks)  Or  Explain Coherent and non coherent detection schemes with appropriate diagrams.  In coherent detection, a strong local oscillator is used, mixing with the optical signal at the receiver and effectively amplifying the weak optical signal. Thus, compared to direct detection, coherent detection has much improved detection sensitivity. (2 Marks)  Coherent Detection - an overview | ScienceDirect Topics. (2 Marks)  Non-coherent detection in digital communication is a technique that detects signals without relying on a reference carrier signal or phase information. Instead, it focuses on the signal's energy, amplitude, or frequency characteristics.  (2 Marks)  (2 Marks) | **8**  **8** | **2**  **2** | **4**  **4** |
| **Part - C (1 x 15 = 15 Marks)**  **Instructions: Answer ANY One Question** | | | | |
| **18(a)**  **18(b)** | What is the need of delta modulation and with the help of neat block diagram.    (3 Marks)   * The present sample value is compared with the previous sample value and the indication, whether the amplitude is increased or decreased is sent. * This step size δ is fixed * The difference between the input signal x(t) and staircase approximated signal confirmed in the two level. i.e. +δ and -δ . * If the difference is positive - increased by one step i.e‘ δ’ (‘1’ is transmitted) * If the difference is negative -reduced by δ. (‘0’ is transmitted ) * When the step is reduced ‘0’ is transmitted and if the step is increased ‘1’ is transmitted. * Thus for each sample one binary bit is transmitted . (6 Marks)   (3 Marks)    (3 Marks)  Or   1. (i) Discuss the concept of M Ary PSK with waveforms. 2. (4 Marks) 3. M-ary Phase Shift Keying (M-PSK) is a digital modulation technique where **M** different phase states are used to represent **M** distinct symbols, each corresponding to a unique sequence of bits. It is a generalization of Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK), where the number of possible phase shifts increases with the number of symbols (M). 4. **Key Concepts of M-Ary PSK:** 5. **M Symbols**: 6. In **M-ary PSK**, the data is transmitted using **M** distinct phase shifts. The number **M** determines the number of distinct symbols that can be transmitted per symbol period. 7. For example: 8. **2-PSK (BPSK)**: Two possible phase states (0° and 180°) representing two symbols. 9. **4-PSK (QPSK)**: Four possible phase states (0°, 90°, 180°, 270°), each representing two bits (since 2^2 = 4). 10. **8-PSK**: Eight possible phase states, representing three bits per symbol. 11. **Symbol Representation**: 12. In M-PSK, each symbol is represented by a unique phase angle. These phases are spaced equally in a 360° circle. 13. For instance, in a 4-PSK system, the four phases would be: 14. Symbol 1: 0° 15. Symbol 2: 90° 16. Symbol 3: 180° 17. Symbol 4: 270° 18. The spacing between phase shifts is **360° / M**. 19. **Bit Representation**: 20. Each phase shift represents a unique combination of bits. For example, in **8-PSK**, there are 3 bits per symbol since 2³ = 8. 21. The bit sequences are mapped to the phase shifts. So, in 8-PSK, the possible bit combinations (000, 001, 010, etc.) correspond to one of the 8 distinct phase states. 22. (4 Marks) 23. (ii) Why do we require constellation diagrams? Substantiate 24. Constellation diagrams are crucial in communication systems, particularly in the fields of signal processing, modulation, and demodulation. They visually represent how different signal points (symbols) are transmitted in a modulation scheme, providing valuable insights into system performance and behavior. Here's why constellation diagrams are required: 25. **1. Understanding Modulation Schemes:** 26. Constellation diagrams help visualize different modulation techniques (e.g., QPSK, BPSK, 16-QAM). Each point on the diagram represents a specific signal or symbol that corresponds to a unique combination of bits in digital communications. 27. By observing the spacing between these points, one can easily determine the level of signal separation, which is directly related to the robustness of the system against noise and interference. 28. **2. Assessing Signal Quality:** 29. The distance between constellation points is an indicator of signal quality. Larger distances between points typically mean less chance of errors, as noise or interference is less likely to cause one point to be misinterpreted as another. 30. If constellation points are too close together, or if there is noise, the points may overlap, leading to symbol errors. 31. **3. Identifying and Analyzing Errors:** 32. Constellation diagrams provide a way to detect and diagnose errors in the received signal. For instance, if the signal points appear scattered or outside their expected locations, it can indicate issues such as noise, distortion, or synchronization problems in the transmission. 33. By comparing the transmitted signal's constellation with the ideal one, engineers can quickly identify and correct problems. 34. **4. Signal Modulation and Demodulation:** 35. For proper demodulation (the process of extracting data from a modulated signal), it’s important to understand how signal points are mapped. The diagram shows the relationship between transmitted symbols and received symbols, aiding in the decision-making process of correctly interpreting the received signal. 36. In high-order modulation schemes like 16-QAM or 64-QAM, constellation diagrams are essential to understand how each symbol (comprising multiple bits) is represented in the signal space. 37. **5. Evaluating System Performance:** 38. The signal-to-noise ratio (SNR) is a key factor in determining the reliability of a communication system. Constellation diagrams allow you to visually assess how noise affects the symbols at different SNR levels. At high SNR, the points will be well-spaced, whereas at low SNR, points may crowd together, showing degraded performance. 39. This helps in making decisions about the required SNR to achieve an acceptable error rate. 40. **6. Optimizing Modulation for Channel Conditions:** 41. By observing how constellation points behave in various conditions (e.g., noisy channels, fading, interference), engineers can adjust the modulation scheme to optimize performance. For example, in a noisy environment, a system might switch to a lower-order modulation to reduce error rates. 42. **7. Designing Efficient Communication Systems:** 43. Constellation diagrams are essential for designing communication systems that balance data rate and error tolerance. By choosing the right modulation scheme, engineers can achieve higher data rates while ensuring that the system is still reliable under expected channel conditions. 44. (7 Marks) | **15**  **8**  **7** | **3**  **3**  **3** | **3**  **4**  **4** |

**Course Outcome (CO) and Bloom’s level (BL) Coverage in Questions**

**Evaluation Sheet**

**Name of the Student: Register No.:**

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| --- | --- | --- | --- | --- |
| **Part- A (11x 1= 11 Marks)** | | | | |
| **Q. No** | **CO** | **Maximum Marks** | **Marks Obtained** | **Total** |
| 1 | 3 | 1 |  |  |
| 2 | 3 | 1 |  |
| 3 | 3 | 1 |  |
| 4 | 3 | 1 |  |
| 5 | 3 | 1 |  |
| 6 | 4 | 1 |  |
| 7 | 4 | 1 |  |
| 8 | 4 | 1 |  |
| 9 | 4 | 1 |  |
| 10 | 4 | 1 |  |
| 11 | 4 | 1 |  |  |
| **Part – B(3 x 8 = 24 Marks)** | | | | |
| 12 a | 3 | 8 |  |  |
| 12 b | 3 | 8 |  |
| 13 a | 3 | 8 |  |
| 13 b | 4 | 8 |  |
| 14 a | 4 | 8 |  |
| 14 b | 4 | 8 |  |
| **Part - C (1 x 15 = 15 Marks)** | | | | |
| 15 a | 3 | 15 |  |  |
| 15 b | 4 | 15 |  |  |

**Consolidated Marks:**

|  |  |  |
| --- | --- | --- |
| **CO** | **Maximum Marks** | **Marks Obtained** |
| **3** | **44** |  |
| **4** | **45** |  |
| **Total** | **89** |  |

**Signature of Course Teacher**

**Signature of the Course Coordinator Signature of the Academic Advisor**