



EEEN 464 – DIGITAL COMMUNICATION

DIGITAL MODULATION - TEST YOUR KNOWLEDGE

1. MULTIPLE CHOICE QUESTIONS

- Digital modulation converts**
 - Analog signals to digital bits
 - Digital bits to analog waveforms**
 - Digital bits to higher frequencies
 - Analog signals to higher frequencies
- The simplest form of amplitude shift keying (ASK) is**
 - QPSK
 - OOK (On-Off Keying)**
 - FSK
 - 16-QAM
- FSK modulates**
 - Amplitude only
 - Phase only
 - Frequency only**
 - Both phase and amplitude
- BPSK has how many phase states?**
 - 1
 - 2**
 - 4
 - 8
- QPSK transmits**
 - 1 bit/symbol
 - 2 bits/symbol**
 - 4 bits/symbol
 - 8 bits/symbol
- The bandwidth efficiency of digital modulation is measured in**
 - Hz/Watt
 - bps/Hz**
 - dB/Hz
 - Seconds/symbol
- In a constellation diagram, points represent**
 - Carrier frequencies
 - Symbol states**

- c) Noise levels
 - d) Bit error rates
8. **Gray coding minimizes**
- a) Bandwidth
 - b) **Bit errors between adjacent symbols**
 - c) Phase shifts
 - d) Carrier power
9. **Which modulation is most resilient to amplitude noise?**
- a) ASK
 - b) **PSK**
 - c) QAM
 - d) OOK
10. **For the same bit rate, which modulation requires the least bandwidth?**
- a) BPSK
 - b) **64-QAM**
 - c) 4-FSK
 - d) OOK

2. TRUE/FALSE QUESTIONS

11. **ASK is highly power-efficient.**
- **False** (Inefficient due to amplitude sensitivity)
12. **DPSK (Differential PSK) eliminates the need for coherent carrier recovery.**
- **True**
13. **Higher-order QAM has better noise immunity than lower-order QAM.**
- **False** (Worse immunity due to smaller constellation spacing)
14. **FSK bandwidth depends only on the carrier frequency.**
- **False** (Depends on frequency separation and symbol rate)
15. **$\pi/4$ -QPSK reduces phase jumps to avoid zero-crossings.**
- **True**

3. SHORT ANSWER QUESTIONS

16. **Define "symbol rate" vs. "bit rate".**
- *Answer:* Symbol rate = symbols/sec; Bit rate = bits/sec = symbol rate \times bits/symbol.
17. **Sketch the constellation for BPSK.**
- *Answer:* Two points at (1,0) and (-1,0) on the I-axis.

18. Why is non-coherent detection used in ASK/FSK?

- Answer: Avoids complex carrier synchronization; uses envelope detection.

19. Calculate bit rate for QPSK with 500 ksymbol/s.

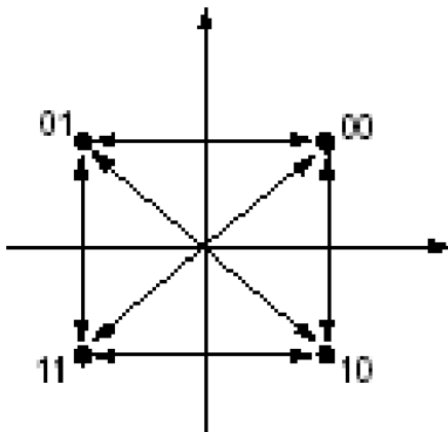
- Answer: $2 \times 500 \times 10^3 = 1000 \times 10^3 = 1 \text{ Mbps}$.

20. What causes inter-symbol interference (ISI)?

- Answer: Bandwidth limitation or multipath propagation distorting symbol boundaries.

DIAGRAM-BASED QUESTIONS

21. Identify the modulation from the constellation:



- Answer: QPSK.

22. Label ASK, FSK, and PSK waveforms:

- Answer: (a) PSK, (b) ASK, (c) FSK.

NUMERICAL PROBLEMS

23. A 16-QAM system transmits 80 Mbps. What is its symbol rate?

- Answer: $\log_2(16) = 4$ bits/symbol $\rightarrow 80/4 = 20 \text{ Msymbol/s}$.

24. The bandwidth of a BPSK signal is 10 MHz. What bandwidth is needed for QPSK at the same bit rate?

- Answer: Half (5 MHz), as QPSK has double the bit/symbol.

25. An FSK system uses frequencies 10 MHz and 15 MHz. Calculate frequency deviation (Δf).

- Answer: $\Delta f = |15 - 10|/2 = 2.5 \text{ MHz}$.

CONCEPTUAL QUESTIONS

26. Explain why PSK is preferred over ASK in noisy channels.

- *Answer:* PSK is immune to amplitude noise; ASK degrades with amplitude variations.

27. How does QAM achieve higher spectral efficiency than PSK?

- *Answer:* QAM encodes bits in both amplitude and phase, packing more bits/symbol.

28. What is the "Nyquist criterion" for zero ISI?

- *Answer:* Bandwidth \geq symbol rate / 2 (for ideal raised-cosine filtering).

29. Why is MSK (Minimum Shift Keying) used in GSM?

- *Answer:* Constant envelope \rightarrow efficient amplification; low spectral sidelobes.

30. List two differences between coherent and non-coherent detection.

- *Answer:*
(1) Coherent requires carrier sync; non-coherent does not.
(2) Non-coherent has higher BER at same SNR.

ANSWER KEY

1. b, 2. b, 3. c, 4. b, 5. b, 6. b, 7. b, 8. b, 9. b, 10. b,
2. F, 12. T, 13. F, 14. F, 15. T,
3. Symbol rate = symbols/sec; bit rate = bits/sec, 17. Two points on I-axis, 18. Avoids carrier sync,
4. 1 Mbps, 20. Bandwidth limitation/multipath,
5. QPSK, 22. (a) PSK, (b) ASK, (c) FSK,
6. 20 Msymbol/s, 24. 5 MHz, 25. 2.5 MHz,
7. PSK immune to amplitude noise, 27. Encodes in amplitude & phase,
8. Bandwidth \geq symbol rate/2, 29. Constant envelope & spectral efficiency,
9. (1) Carrier sync, (2) BER performance.