AMERICAN INTERNATIONAL UNIVERSITY – BANGLADESH
Faculty of Engineering

Course/Lab Name:	Data Communication	
Semester: Spring 2024-25	**Term**: Final	**Assignment for Final Term**

Question Mapping with Course Outcomes:

Item	COs	POIs	K	P	A	Marks	Obtained Marks
All Problems	**CO4**	**P.f.2.C6**	**K7**	**.**	**.**	**10**	

Student Information:

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Section: D	**Department: CSE**

Instructions for submission:

1. Use this page as a cover page.
2. Use A4 size paper and only **handwritten** answers are acceptable.
3. Submit a **hard copy** of your assignment to my office by **June 1st, 2025**.
3. **The submission will not be considered if the instructions are not followed.**

CO4 Description:	Design solution for frequency division multiplexing problems in accordance with professional practices

Answer the following Questions:

Problem 01: Assume four baseband signals, each with a bandwidth of 4 kHz, are to be transmitted over a shared communication link using Amplitude Modulation (AM) and Frequency Division Multiplexing (FDM). The total transmission link bandwidth is 44 kHz, spanning from 56 kHz to 100 kHz. To avoid inter-channel interference, a 4 kHz guard band is maintained between any two adjacent channels. (***i***) **Compute** the carrier frequencies to be assigned for AM modulation of each baseband signal, ensuring proper spacing for the guard bands, (***ii***) **Illustrate** the entire configuration using the time domain equations and frequency domain representation for both FDM multiplexer with AM modulation and demultiplexer with AM demodulation.

Problem 02: Consider five ground stations each transmitting data at a rate of 12 Gbps to a nearest low earth orbit satellite through a bandwidth-limited uplink channel of 15.04 GHz. (***i***) **Compute** the effective bandwidth per ground station if bandwidth is allocated evenly while keeping 10 MHz band gap between each ground stations to avoid interference, (***ii***) **Choose** an appropriate modulation scheme and **compute** its modulation order '***M***', (***iii***) **Design** a suitable configuration to multiplex the five ground stations using the chosen modulation scheme and FDM with proper illustration. (***iv***) **Sketch** the constellation diagram for 16−QAM, ensuring the following:

- Properly label the axes for in-phase and quadrature components.
- Represent signal amplitudes as $\pm A$ and $\pm 3A$ volts.
- Clearly indicate and label all 16 constellation points.

------The End-----

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(1) ① Given, N = 4
B = 4 KHz
G = 4 KHz

Total Bandwith = 44 KHz spanning form 56 KHz to 100 KHz.

$B_{total} = B + G = 4 + 4 = 8$ KHz

Calculate Carries frequency = f_c

$f_{c1} = \frac{56+60}{2} = 58$ KHz

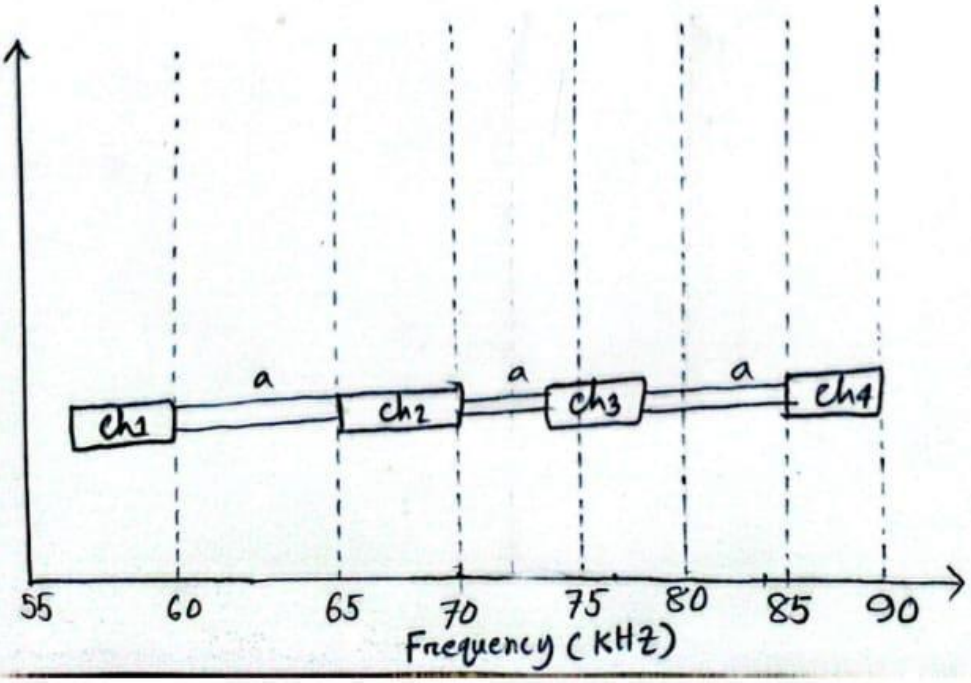
$f_{c2} = \frac{64+68}{2} = 66$ KHz

$f_{c3} = \frac{72+76}{2} = 74$ KHz

$f_{c4} = \frac{80+84}{2} = 82$ KHz

The carrier frequency's are 58 KHz, 66 KHz, 74 KHz and 82 KHz

2 ⑪



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2(i) Total available bandwidth:

$B_{total} = 15.04\ GHz$

Guand band between stations

$(4\ gaps) \times 10\ MHz = 40\ MHz = 0.04\ GHz$

$B_{available} = 15.04 - 0.04\ GHz$

$= 15.00 GHz$

$B_{pen\ station} = \frac{15.00}{5}$

$= 3.00\ GHz$

(ii) Given, Data rate = 12 Gbps pen ground station

Bandwidth pen station = 3GHz

$n = \text{Data rate} = \frac{12\ Gbps}{3\ GHz}$

$= 4\ bps/Hz$

Spectral efficency of 4bps/Hz Using 1QAM.

$n = \log_2 M$

$\Rightarrow M = 2^n$

$\Rightarrow M = 2^4$

$\Rightarrow M = 16$

$\therefore M = 16$

(iii) Configuration for multiplexing

each station

3GHz of bandwidth

10MHz gaurd bands between them to prevent interface

Frequency allocation layout:

station	Band start (GHz)	Band End (GHz)
GS1	0.000	3.000
GS2	3.010	6.010
GS3	6.020	9.020
GS4	9.030	12.030
GS5	12.040	15.040

(iv) Amplitude levels ± A and ±3A

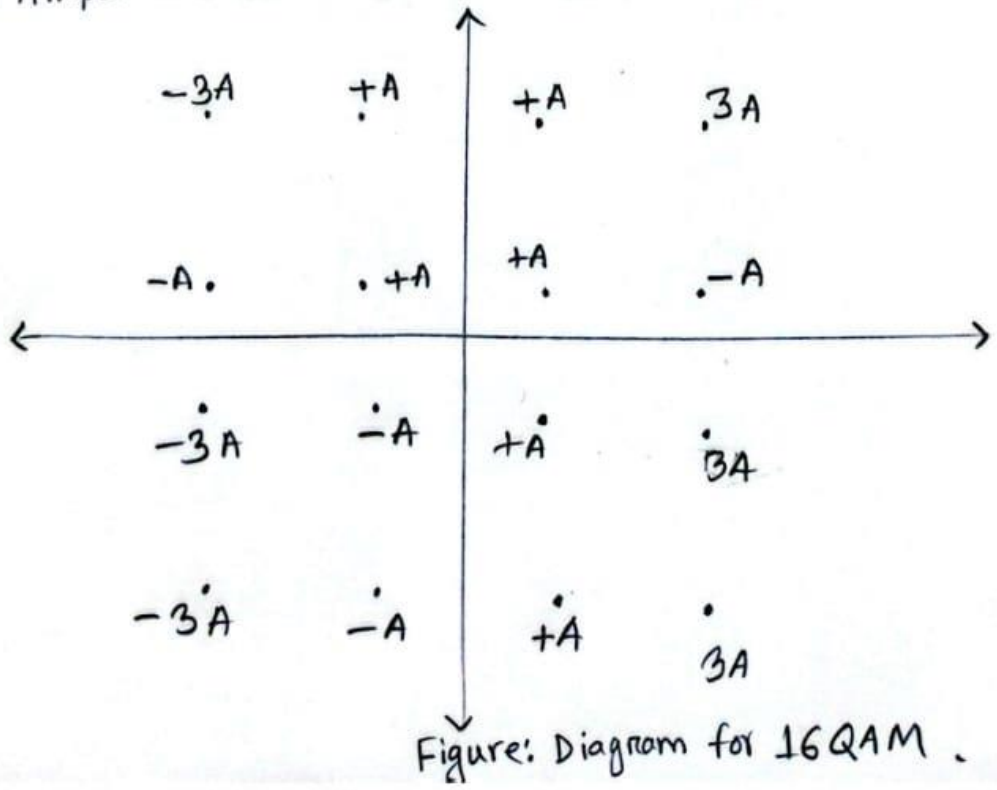

Figure: Diagram for 16QAM.