AMERICAN INTERNATIONAL UNIVERSITY – BANGLADESH
Faculty of Engineering

Course/Lab Name:	Data Communication	
Semester: Fall 2025-26	**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**	**.**	**.**	**15**	

Student Information:

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Section:	C	**Department:**	CSE

Instructions for submission:

1. Use this page as a cover page. Each student individually submit this assignment.
2. Use A4 size paper and only **handwritten** answers are acceptable.
3. Submit a **hard-written copy** of your assignment to my office by **Jan 07, 2025 (5:00pm)**.
4. **Copied/identical submissions will be graded as 0 for all parties concerned.**
5. **The submission will not be considered if the instructions are not followed. Also, if you miss the deadline for each delayed day 3 marks will be deducted.**

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

Answer the following Questions:

Problem 01: Assume four baseband signals, each with a bandwidth of 5 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 52 kHz, spanning from 200 kHz to 252 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.

Note: For FDM demultiplexing you should use both bandpass and low pass filter with full AM demodulation to recover each Baseband signals.

Problem 02: Assume five ground stations each transmitting digital data to a nearest LEO satellite utilizing the Ku-band uplink spectrum spanning between 14.25–14.50 GHz. The uplink uses digital modulation and FDM with 5000 kHz guard bands between adjacent channels. (**i**) **Compute** the effective bandwidth per ground station if bandwidth is allocated evenly, (**ii**) **Compute** the bit rate using Nyquist bit rate equation if BPSK, QPSK, 16-QAM, and 64-QAM modulation scheme is used, (**iii**) **Compute** the probability of BER (P_b) for BPSK, QPSK, 16-QAM, and 64-QAM for SNR/bit $\frac{E^b}{N_0} = 2, 4, 6$ dB, respectively in AWGN channel, and (**iv**) **Identify** the reason why the BER probability is the same for BPSK and QPSK. (**Note**: Use Q-function table to get probability of BER for $\mathrm{Q}(x)$ and You should convert $\frac{E^b}{N_0}$ from dB to linear scale to calculate the BER probability using the equations given in Lecture 8).

Problem 03: Consider four input data channels: the first two channels with a bit rate of 50 bytes/second, the third channel with a bit rate of 100 bytes/second, and the fourth channel with a bit rate of 397 bps, which need to be multiplexed using synchronous TDM. A maximum of 3 bps data can be added by using the pulse stuffing method only in the lowest data rate channel and each input channel speed must not exceed 400 bps. The interleaved size of data is 1 byte. (**i**) **Illustrate** the data rate mismatch problem solution by adopting suitable data rate management techniques for a synchronous TDM multiplexer. Then, **compute** the following: (**ii**) frame rate, (**iii**) frame duration, (**iv**) bit rate at the output link, and (**v**) output bit duration.

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