

Object-Oriented Programming and Design - Monsoon 2025

Project Involving Multiple Concepts

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This assignment carries a total of 150 marks. You can do this assignment in groups of 2-4 students. Assessment of each student would be done separately.

The goal of this project is to design a cellular network simulator. The use of object-oriented features such as inheritance, data abstraction, data hiding and polymorphism is essential.

1. **Simulation Framework:** Create a simulator framework where you have a total of three different types of classes – user device, cell tower and cellular core. Assume that the cellular core generates messages, depending on the type of protocol used, and the amount of overhead generated per 100 messages imposes a limit on the number of user devices. Another limit imposed is the fact is the number of users that can be accommodated per frequency. You are required to specify how many users a single cell tower can accommodate, and identify the users who are occupying a specific frequency.
2. **2G Communication** 2G communication in cell towers uses packet switching for data and circuit switching for voice. It also uses time division multiple access, which can satisfy a maximum of 16 users per 200 kHz. Each user device connection creates a total of 5 messages each for data, and 15 messages for voice. Assuming that a total of 1 MHz is allocated, provide how many user devices can be supported, and the users occupying the first channel (first band of 200 kHz) within the 2G spectrum.
3. **3G Communication** 3G communication uses packet switching for both data and voice. It uses code-division multiple access, where instead of splitting across time, the data is mixed with a specific digital code. A single user device generates a total of 10 messages to be supported. This allows a total of 32 users per 200 kHz channel. Answer the same questions as above for this use case.
4. **4G Communication** 4G communication continued with the above, but moved to OFDM, which allowed splitting into even smaller sub-channels. Assume that a total of 30 users are assigned to 10 kHz, and that each user still takes 10 messages to be supported. Furthermore, it also allows use of up to 4 antennas in parallel, where the same channels can be re-used. Again, answer the same questions as above. Also identify the number of cellular cores that need to be used to use the full potential.

5. **5G Communication** 5G communication in addition moved to supporting higher frequency channels of another 10 MHz at 1800 MHz. However, to support higher data rates, the 1800 MHz only supports a total of 30 users per 1 MHz. It also supports massive MIMO with a much larger number of antennas of up to 16. Answer the same questions as above.

What and How To Submit

- The C++ program sources. Templates and exception handling must be utilized.
- **Makefile** to compile the sources and generate the running binary for the shell. The Makefile should generate two versions of the binary – one for debugging and another for optimized execution.
- A readme text file, explaining the commands needed to build the file, and the format of the input files. If code is copied from anywhere else (not that copying from any other student is plagiarism, but using textbook or open-source code is allowed), that should be mentioned here.
- At least 4 significant commits on a **private** github repository, with proper descriptions of the commits. You may have as many commits as you wish.
- Make the assigned TA the admin of the github repository, **and** submit the same code in zipped form on Google Classroom by the due date.

Late Submission Policy

- Late submissions would only be allowed under exceptional circumstances. Please ensure that you submit the project on time.