EXP 4: OFDMA Resource Block Allocation Simulation

a) The objective is to simulate downlink and uplink OFDMA resource allocation for multiple users to study dynamic assignment of subcarriers and time slots.

b) The objective is to visualize subcarrier and time-slot allocation to understand how resources are distributed among users in the system.

c) The objective is to analyze spectral efficiency and throughput to evaluate the performance and effectiveness of OFDMA-based multiuser communication.

AIM: To simulate downlink (DL) and uplink (UL) OFDMA resource allocation for multiple users, visualize the allocation of subcarriers and time-slots, and evaluate throughput and spectral efficiency.

THEORY:

Orthogonal Frequency Division Multiple Access (OFDMA) is a multi-user version of OFDM in which:

- The total bandwidth is divided into several orthogonal subcarriers.

Two schedulers are typically analyzed:

a) Round Robin (RR)

b) Proportional Fair (PF)

Allocates RBs based on:

$$\text{PF Metric} = \frac{\text{Instantaneous Rate}}{\text{Average Rate}}$$

Throughput per RB depends on SNR and modulation:

$$R = \log_2(1 + \text{SNR})$$

Total throughput:

$$T_u = \sum R \cdot \text{Allocated RBs}$$

Spectral efficiency:

$$SE = \frac{\text{Total Throughput}}{\text{Bandwidth}}$$

PROCEDURE:

- Initialize system parameters: number of users, subcarriers, OFDM symbols, transmit powers, noise level, bandwidth, and choose scheduler.
- Generate channel coefficients for each user and subcarrier and apply large-scale path loss or shadowing if needed.
- Compute instantaneous SNR for every user and subcarrier.
- Prepare the allocation grid with dimensions for subcarriers × OFDM symbols × frames.
- For Round-Robin: assign users cyclically across OFDM symbols/subcarriers so each user gets fair time–frequency slots.
- For Proportional-Fair: compute instantaneous achievable rate per RE, select the user with the highest metric for each RE, and update the user's average rate with exponential smoothing.
- Map SNR to bits per resource element using your MCS table (or use $\log_2(1 + \text{SNR})$.
- Sum allocated bits per user across all allocated REs in the simulated interval to get per-user throughput.
- Compute total system throughput and spectral efficiency = total throughput / system bandwidth.
- Visualize the throughput bar chart.
- Analyze results: compare RR vs PF in terms of fairness and throughput, check spectral efficiency.

CODE:

```
clear; clc; close all;

%% PARAMETERS

N_RB = 20;          % total resource blocks

N_users = 5;        % number of users


%% ------------------ Equal Allocation ------------------

base = floor(N_RB / N_users);

rem = mod(N_RB, N_users);

alloc_equal = zeros(1,N_RB);

idx = 1;

for u=1:N_users

    take = base + (u<=rem);

    alloc_equal(idx:idx+take-1) = u;

    idx = idx + take;

end


%% ------------------ Round-Robin Allocation ------------------

alloc_rr = zeros(1,N_RB);

for rb = 1:N_RB

    alloc_rr(rb) = mod(rb-1, N_users) + 1;

end
```

```
%% ------------------ PLOT ------------------
figure;
subplot(2,1,1);
imagesc(alloc_equal);
colormap(parula(N_users));
colorbar('Ticks',1:N_users,'TickLabels',{'U1','U2','U3'});
title('Equal RB Allocation');
xlabel('Resource Block Index'); ylabel('Time Slot');

subplot(2,1,2);
imagesc(alloc_rr);
colormap(parula(N_users));
colorbar('Ticks',1:N_users,'TickLabels',{'U1','U2','U3'});
title('Round-Robin RB Allocation');
xlabel('Resource Block Index'); ylabel('Time Slot');

%% ------------------ DISPLAY ------------------
disp('Equal Allocation:');
disp(alloc_equal);
disp('Round-Robin Allocation:');
disp(alloc_rr);
```

OUTPUT:

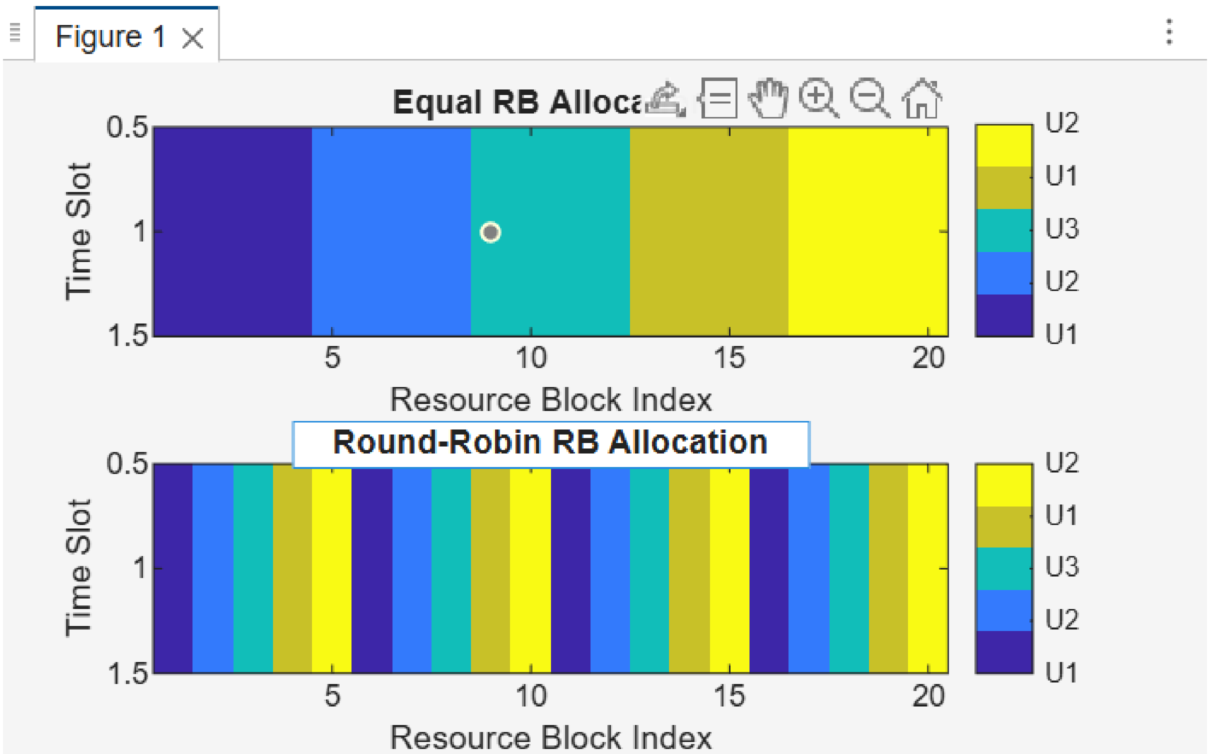
Equal Allocation:

1 1 1 1 2 2 2 2 3 3 3 3 4 4 4 4 5 5
5 5

Round-Robin Allocation:

1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3
4 5

>>



RESULT:

OFDMA simulation shows that dynamic subcarrier allocation improves spectral efficiency and user performance. RR ensures fairness, while PF increases overall throughput by using channel variations effectively.