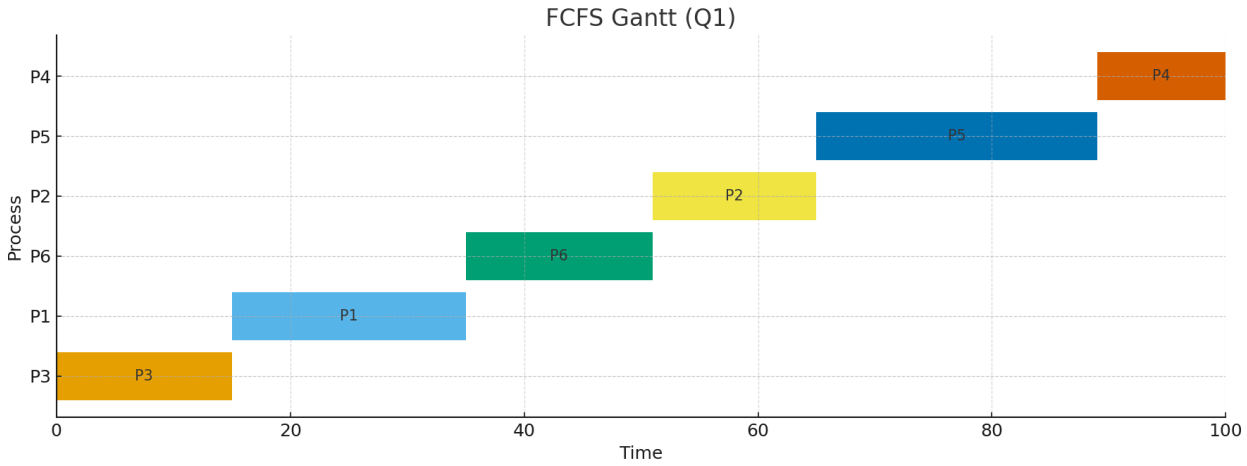
Operating System: Assignment 3

Brysen Pfingsten

October 23, 2025

Question 1

a) Gantt Chart



b) Table

Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Wait Time	Response Time
P1	2	20	35	33	13	13
P2	5	14	65	60	46	46
P3	0	15	15	15	0	0
P4	8	11	100	92	81	81
P5	6	24	89	83	59	59
P6	3	16	51	48	32	32

c) Work

Policy. Non-preemptive FCFS (First-Come, First-Served). Let A_i be arrival, B_i be burst, S_i start, C_i completion, T_i turnaround, W_i waiting, R_i response. For FCFS:

$$
\begin{aligned}
S_i &= \max\{C_{\text{prev}},\, A_i\},\\
C_i &= S_i + B_i,\\
T_i &= C_i - A_i,\\
W_i &= T_i - B_i,\\
R_i &= S_i - A_i \quad (\text{for FCFS, } R_i = W_i).
\end{aligned}
$$

Determine execution order (by arrival)

Sorted by arrival time: $\boxed{P_3 \to P_1 \to P_6 \to P_2 \to P_5 \to P_4}$.

Compute S_i and C_i

$$\textbf{For } P_3: \quad S_3 = \max\{0, 0\} = 0, \quad C_3 = 0 + 15 = 15.$$

$$\textbf{For } P_1: \quad S_1 = \max\{C_3, A_1\} = \max\{15, 2\} = 15, \quad C_1 = 15 + 20 = 35.$$

$$\textbf{For } P_6: \quad S_6 = \max\{C_1, A_6\} = \max\{35, 3\} = 35, \quad C_6 = 35 + 16 = 51.$$

$$\textbf{For } P_2: \quad S_2 = \max\{C_6, A_2\} = \max\{51, 5\} = 51, \quad C_2 = 51 + 14 = 65.$$

$$\textbf{For } P_5: \quad S_5 = \max\{C_2, A_5\} = \max\{65, 6\} = 65, \quad C_5 = 65 + 24 = 89.$$

$$\textbf{For } P_4: \quad S_4 = \max\{C_5, A_4\} = \max\{89, 8\} = 89, \quad C_4 = 89 + 11 = 100.$$

Per-process calculations

$$\mathbf{P}_1: T_1 = C_1 - A_1 = 35 - 2 = 33, \quad W_1 = T_1 - B_1 = 33 - 20 = 13, \quad R_1 = S_1 - A_1 = 15 - 2 = 13.$$

$$\mathbf{P}_2: T_2 = C_2 - A_2 = 65 - 5 = 60, \quad W_2 = T_2 - B_2 = 60 - 14 = 46, \quad R_2 = S_2 - A_2 = 51 - 5 = 46.$$

$$\mathbf{P}_3: T_3 = C_3 - A_3 = 15 - 0 = 15, \quad W_3 = T_3 - B_3 = 15 - 15 = 0, \quad R_3 = S_3 - A_3 = 0 - 0 = 0.$$

$$\mathbf{P}_4: T_4 = C_4 - A_4 = 100 - 8 = 92, \quad W_4 = T_4 - B_4 = 92 - 11 = 81, \quad R_4 = S_4 - A_4 = 89 - 8 = 81.$$

$$\mathbf{P}_5: T_5 = C_5 - A_5 = 89 - 6 = 83, \quad W_5 = T_5 - B_5 = 83 - 24 = 59, \quad R_5 = S_5 - A_5 = 65 - 6 = 59.$$

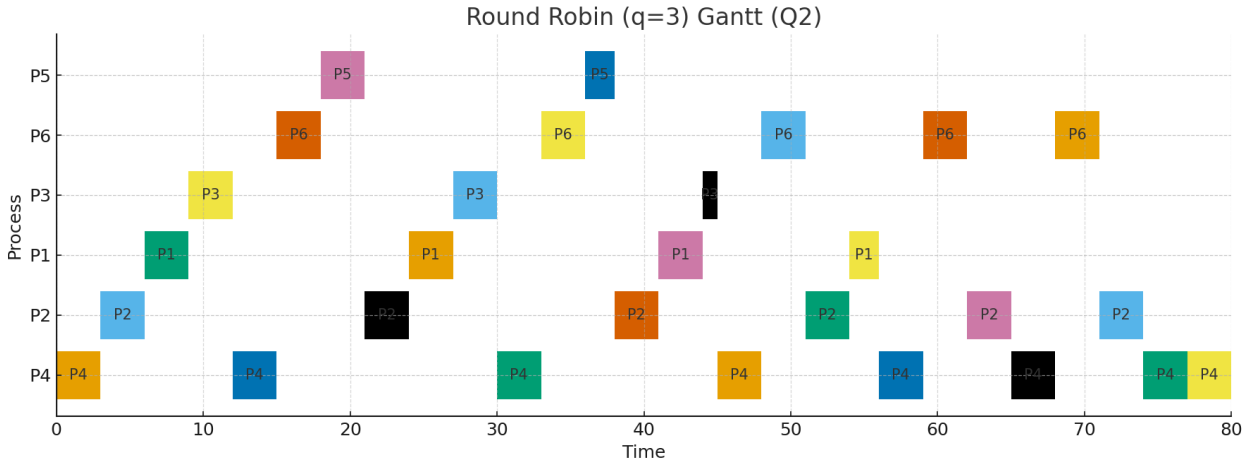
$$\mathbf{P}_6: T_6 = C_6 - A_6 = 51 - 3 = 48, \quad W_6 = T_6 - B_6 = 48 - 16 = 32, \quad R_6 = S_6 - A_6 = 35 - 3 = 32.$$

d) Averages

$$\overline{W} = \frac{13 + 46 + 0 + 81 + 59 + 32}{6} = \frac{231}{6} = 38.5,$$
$$\overline{T} = \frac{33 + 60 + 15 + 92 + 83 + 48}{6} = \frac{331}{6} \approx 55.17,$$

Question 2

a) Gantt Chart



b) Table

Process	Arrival Time	Burst Time	Completion Time	Turnaround Time	Wait Time	Response Time
P1	2	11	56	54	43	4
P2	1	18	74	73	55	2
P3	3	7	45	42	35	6
P4	0	24	80	80	56	0
P5	6	5	35	29	24	9
P6	4	15	68	64	49	8

c) Work

Execution Times

Round 1

$\boxed{0-3 : P_4}$, $\boxed{3-6 : P_2}$, $\boxed{6-9 : P_1}$, $\boxed{9-12 : P_3}$,
$\boxed{12-15 : P_6}$, $\boxed{15-18 : P_5}$.

Round 2

$\boxed{18-21 : P_4}$, $\boxed{21-24 : P_2}$, $\boxed{24-27 : P_1}$, $\boxed{27-30 : P_3}$,
$\boxed{30-33 : P_6}$, $\boxed{33-35 : P_5 \text{ (finishes at 35)}}$,

Round 3

$\boxed{35-38 : P_4}$, $\boxed{38-41 : P_2}$, $\boxed{41-44 : P_1}$,
$\boxed{44-45 : P_3 \text{ (finishes at 45)}}$, $\boxed{45-48 : P_6}$,

Round4

$\boxed{48-51 : P_4}$, $\boxed{51-54 : P_2}$, $\boxed{54-56 : P_1 \text{ (finishes at 56)}}$, $\boxed{56-59 : P_6}$,

Round5

$\boxed{59-62 : P_4}$, $\boxed{62-65 : P_2}$, $\boxed{65-68 : P_6 \text{ (finishes at 68)}}$,

Round 6

$\boxed{68-71 : P_4}$, $\boxed{71-74 : P_2 \text{ (finishes at 74)}}$, $\boxed{74-80 : P_4 \text{ (finishes at 80)}}$.

First response times

$$R_1 = 6 - 2 = 4, \quad R_2 = 3 - 1 = 2, \quad R_3 = 9 - 3 = 6,$$
$$R_4 = 0 - 0 = 0, \quad R_5 = 15 - 6 = 9, \quad R_6 = 12 - 4 = 8.$$

Completion ⇒ Turnaround, Waiting

From the Gantt above:

$$C_1 = 56,\ C_2 = 74,\ C_3 = 45,\ C_4 = 80,\ C_5 = 35,\ C_6 = 68.$$

Then

$$T_1 = C_1 - A_1 = 56 - 2 = 54, \quad W_1 = T_1 - B_1 = 54 - 11 = 43,$$
$$T_2 = 74 - 1 = 73, \quad W_2 = 73 - 18 = 55,$$
$$T_3 = 45 - 3 = 42, \quad W_3 = 42 - 7 = 35,$$
$$T_4 = 77 - 0 = 80, \quad W_4 = 80 - 24 = 56,$$
$$T_5 = 35 - 6 = 29, \quad W_5 = 29 - 5 = 24,$$
$$T_6 = 68 - 4 = 64, \quad W_6 = 64 - 15 = 49.$$

Averages

$$\overline{W} = \frac{43 + 55 + 35 + 56 + 24 + 49}{6} = \frac{262}{6} \approx 43.67$$
$$\overline{T} = \frac{54 + 73 + 42 + 80 + 29 + 64}{6} = \frac{342}{6} = 57.00,$$