

ECE – 6100
Tomasulo Algorithm Pipelined Processor
PROJECT REPORT
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Assumptions / Limitations:

In any clock cycle, results from previous clock cycle that were added to result buses would be updated to schedule queue and register file. Thus, in every clock entire result bus is free to be updated by the FUs.

Hence, I am assuming that maximum R is equal to $K_0+K_1+K_2$ because in any clock cycle at-most all the FUs will need to update the result bus.

I am assuming that we get the best IPC when R, K_0 , K_1 and K_2 are maximum i.e. 6,2,2,2. We can then change F=4 and 8 to check the best case IPC.

I observed that when K_0 or K_1 or K_2 is reduced to 1 for the same R and F, we get a significant drop in IPC. Hence, it will be observed that $K_0=K_1=K_2=2$ would be the used case.

Dispatch queue size is assumed to be infinite which will not be the case in actual system. It was observed that average dispatch queue size was $> 25,000$ which is very high. Thus, in an actual system observed IPC would be way less than what is observed in this project.

We keep dead entries in schedule queue even though they have been fired which I don't think is required. This increases the schedule queue size and imposes the restriction that schedule queue size be twice the number of FUs because FUs can update result bus which will then delete the entries from schedule queue only in next cycle and we need to have extra instructions in schedule queue which can be put in FU.

We are assuming that every FU gives a latency of 1 which may not be the case in actual system. And if FU is pipelined then it can demand a higher schedule queue size which has not been considered.

Experiment Methodology:

To decide on the configuration for a trace, I am following the below steps:

1. Set $R=6$, $K_0=K_1=K_2=2$. Check with F=4 and 8 to get the best case IPC.
2. Set F=value from (1) and $R=5$. Check if IPC obtained by reducing either K_0 or K_1 or K_2 to 1 achieves 95% best case IPC.
3. Fix F, K_0 , K_1 and K_2 from (2). Now get least R to get 95% of IPC from (1).

In step2 we choose $R=5$ because there are only 5 FUs in the test. Thus, $R=6$ should not result in better IPC compared to $R=5$.

GCC:

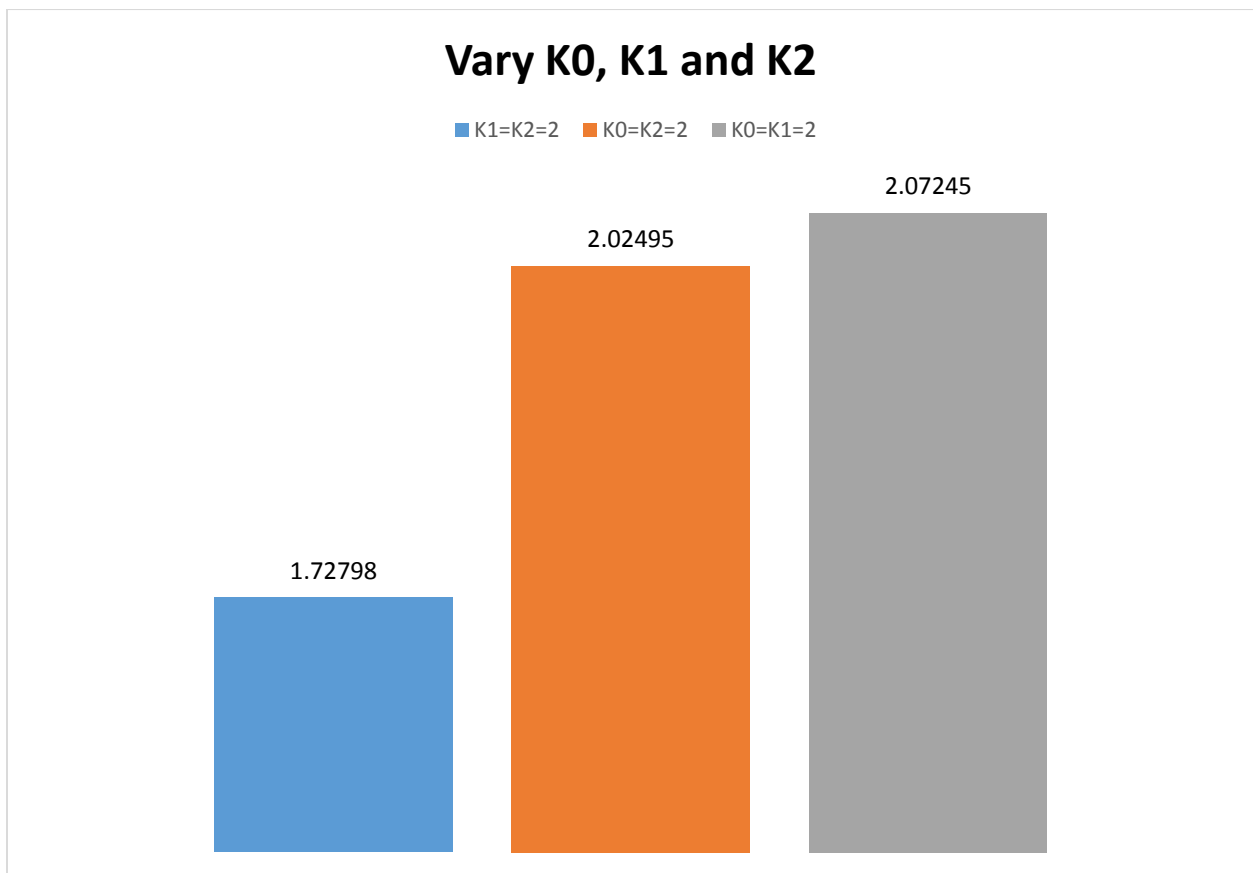
R	K0	K1	K2	F	Trace	IPC
6	2	2	2	4	gcc	2.42207
6	2	2	2	8	gcc	2.42207

$$IPC_{\max} = 2.42207$$

Thus, target $IPC > 0.95 * IPC_{\max} > 2.3009$

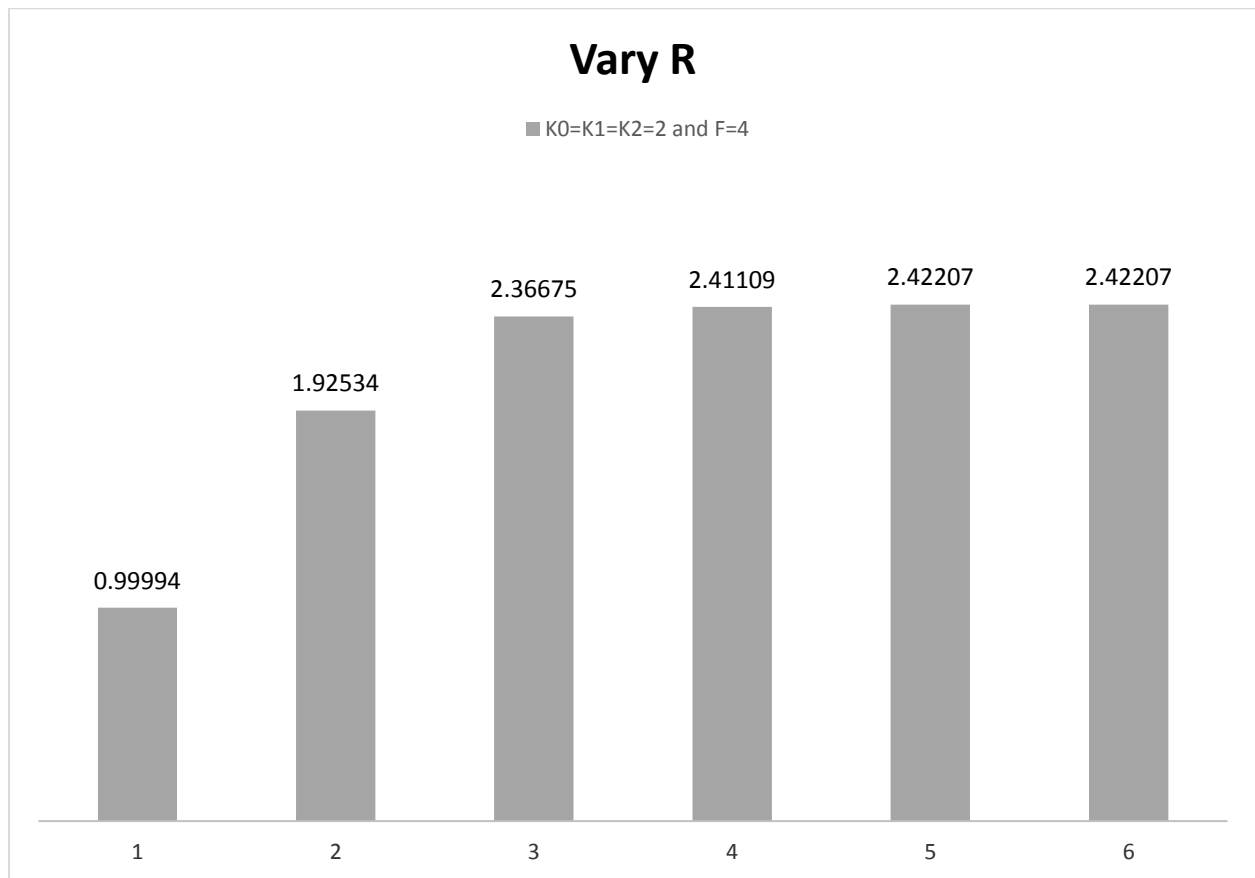
Set $R=5$, $F=4$.

- With $K1=K2=2$ and $K0=1$
- With $K0=K2=2$ and $K1=1$
- With $K0=K1=2$ and $K2=1$



From the graph we can observe that when either $K0$ or $K1$ or $K2$ is reduced to 1 we get $IPC < 2.3009$. Thus, we need to set $K0=K1=K2=2$.

Set $K_0=K_1=K_2=2$ and $F=4$. Vary R .



Thus, $K_0=K_1=K_2=2$, $R=3$ and $F=4$ is the configuration needed that gives IPC of 2.36675

GOMBK:

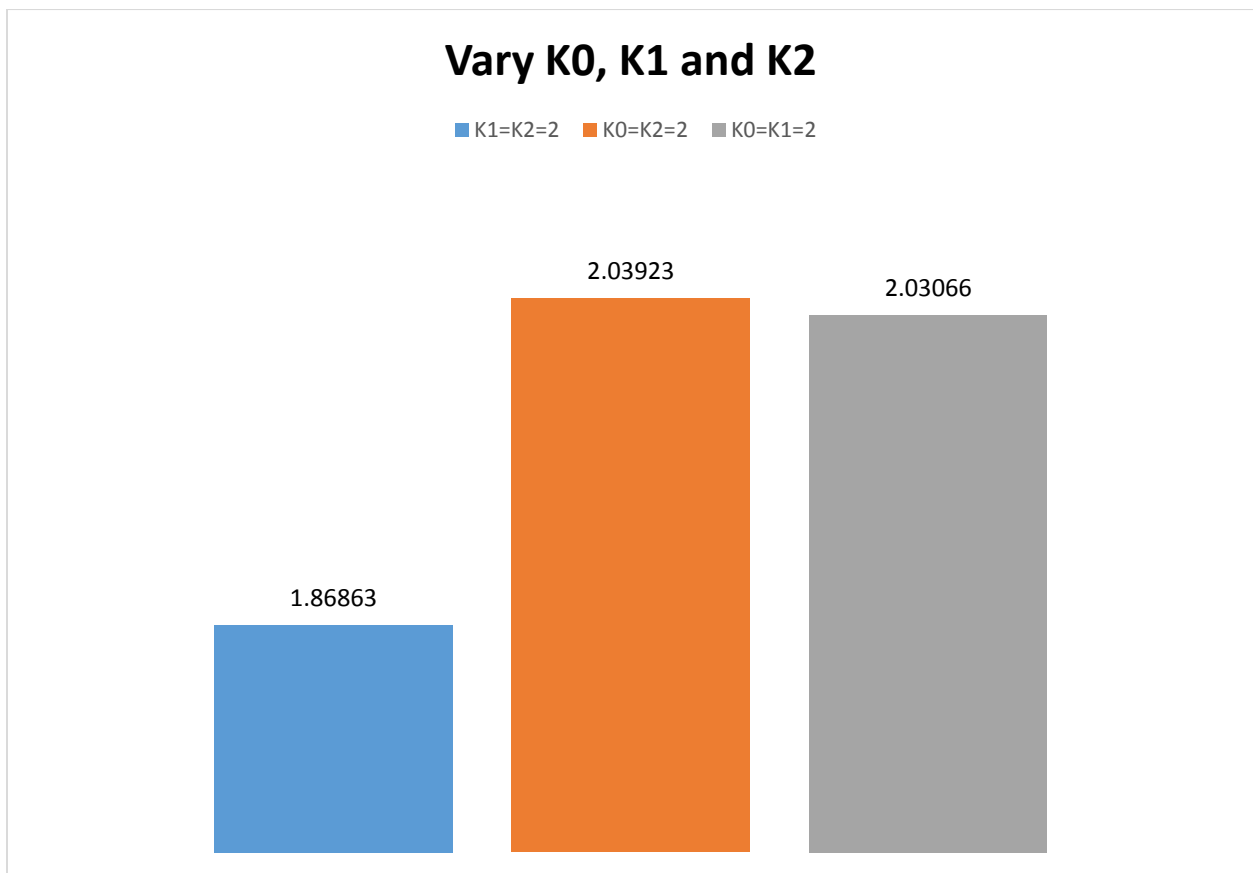
R	K0	K1	K2	F	Trace	IPC
6	2	2	2	4	gobmk	2.36446
6	2	2	2	8	gobmk	2.36446

$$IPC_{\max} = 2.36446$$

Thus, target $IPC > 0.95 * IPC_{\max} > 2.246237$

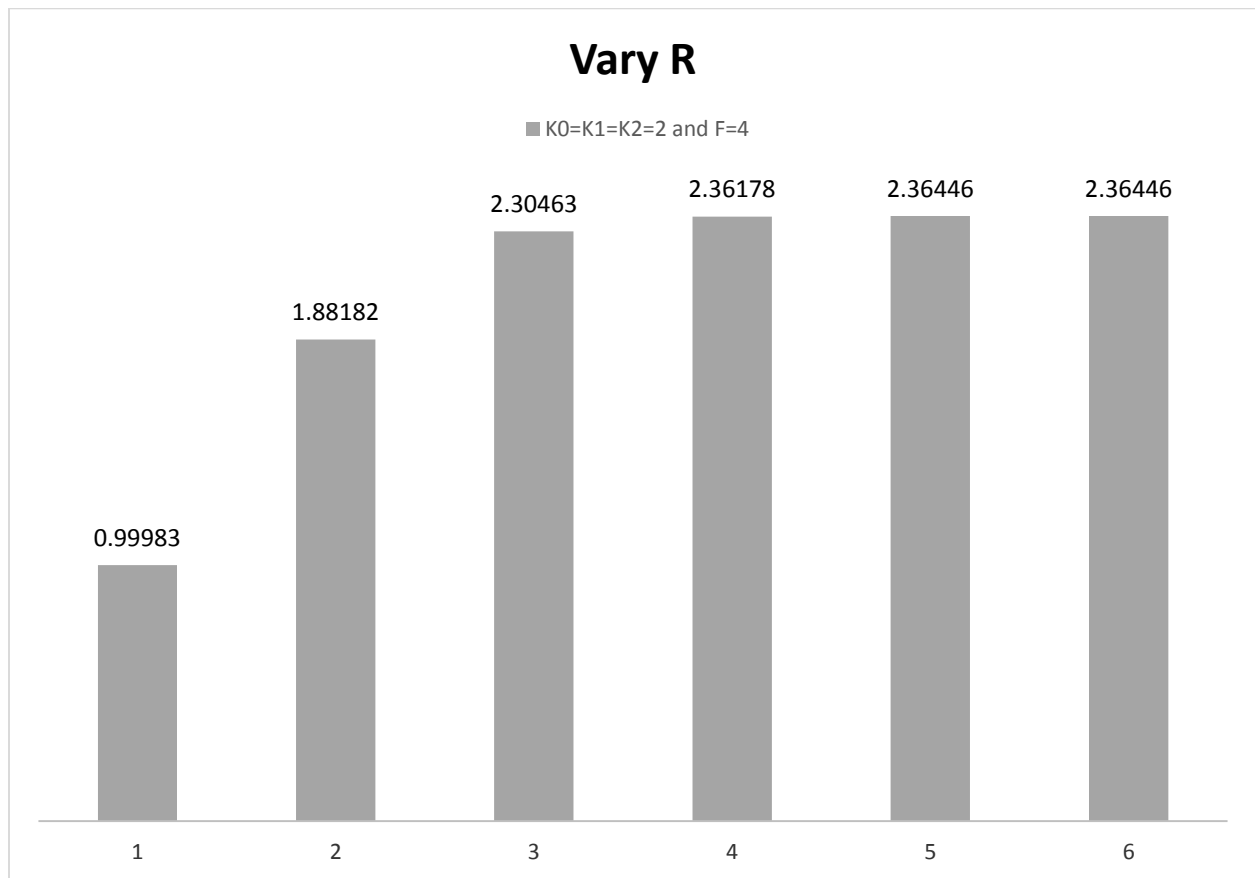
Set $R=5$, $F=4$.

- With $K1=K2=2$ and $K0=1$
- With $K0=K2=2$ and $K1=1$
- With $K0=K1=2$ and $K2=1$



From the graph we can observe that when either $K0$ or $K1$ or $K2$ is reduced to 1 we get $IPC < 2.246237$. Thus, we need to set $K0=K1=K2=2$.

Set $K_0=K_1=K_2=2$ and $F=4$. Vary R .



Thus, $K_0=K_1=K_2=2$, $R=3$ and $F=4$ is the configuration needed that gives IPC of 2.30463

HMMER:

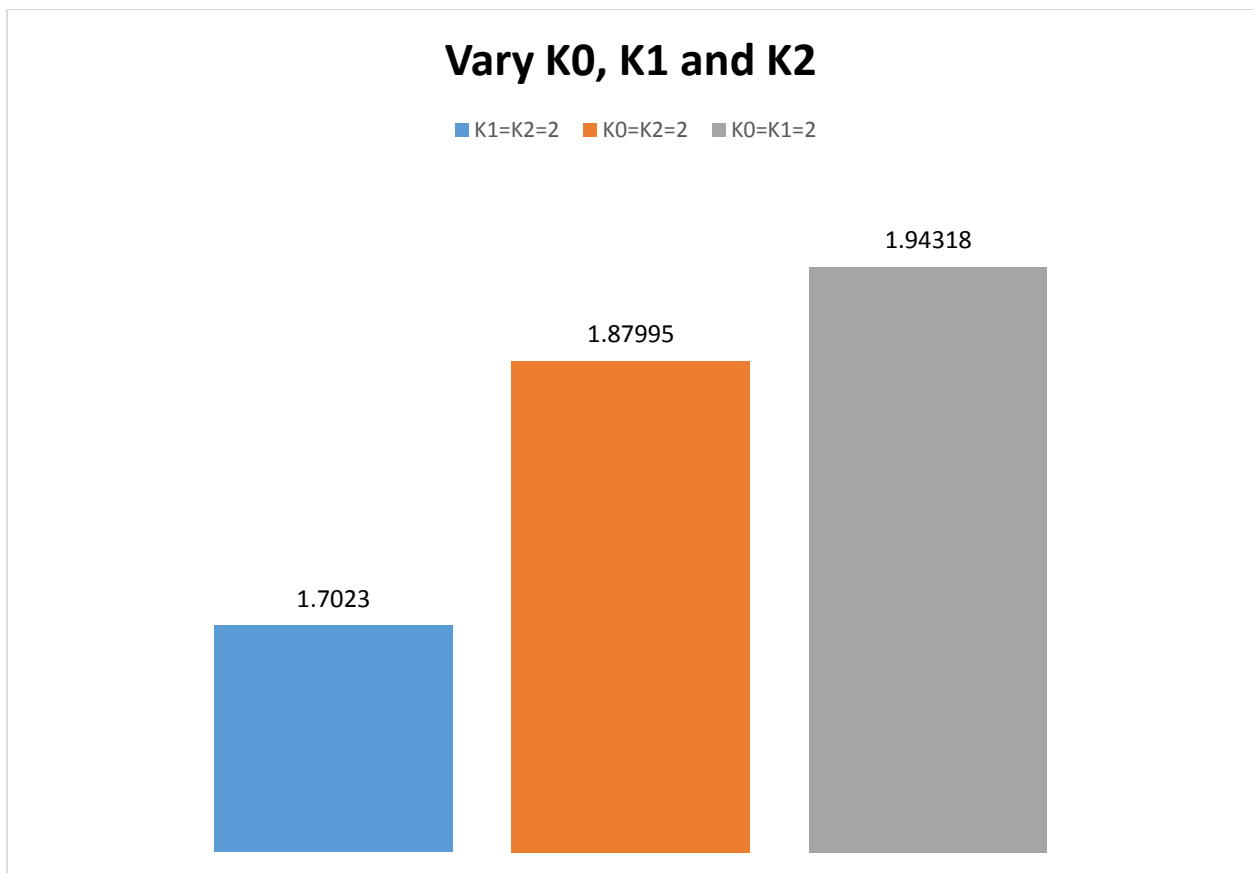
R	K0	K1	K2	F	Trace	IPC
6	2	2	2	4	hammer	2.26685
6	2	2	2	8	hammer	2.26685

$$IPC_{\max} = 2.26685$$

Thus, target $IPC > 0.95 * IPC_{\max} > 2.1535075$

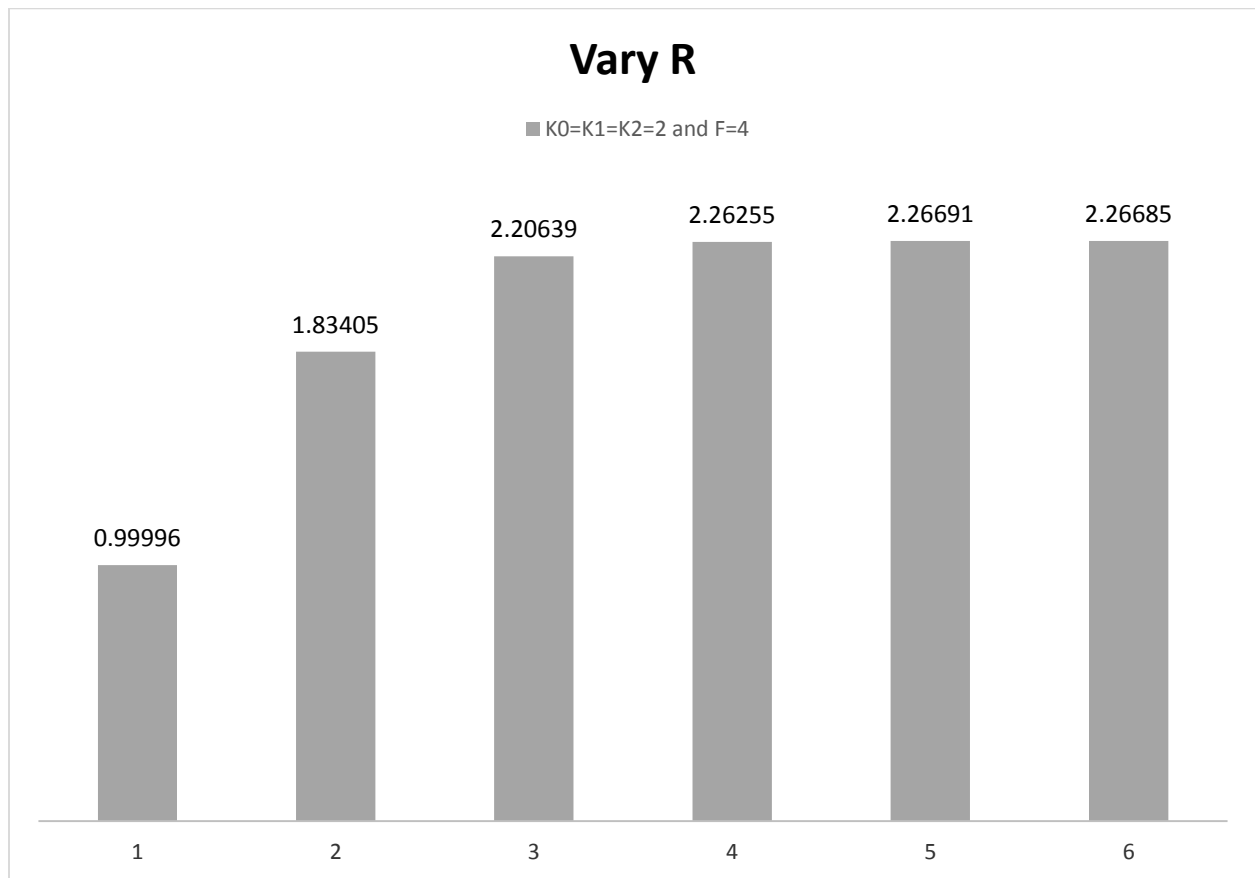
Set $R=5$, $F=4$.

- With $K1=K2=2$ and $K0=1$
- With $K0=K2=2$ and $K1=1$
- With $K0=K1=2$ and $K2=1$



From the graph we can observe that when either $K0$ or $K1$ or $K2$ is reduced to 1 we get $IPC < 2.1535075$. Thus, we need to set $K0=K1=K2=2$.

Set $K_0=K_1=K_2=2$ and $F=4$. Vary R .



Thus, $K_0=K_1=K_2=2$, $R=3$ and $F=4$ is the configuration needed that gives IPC of 2.20639

MCF:

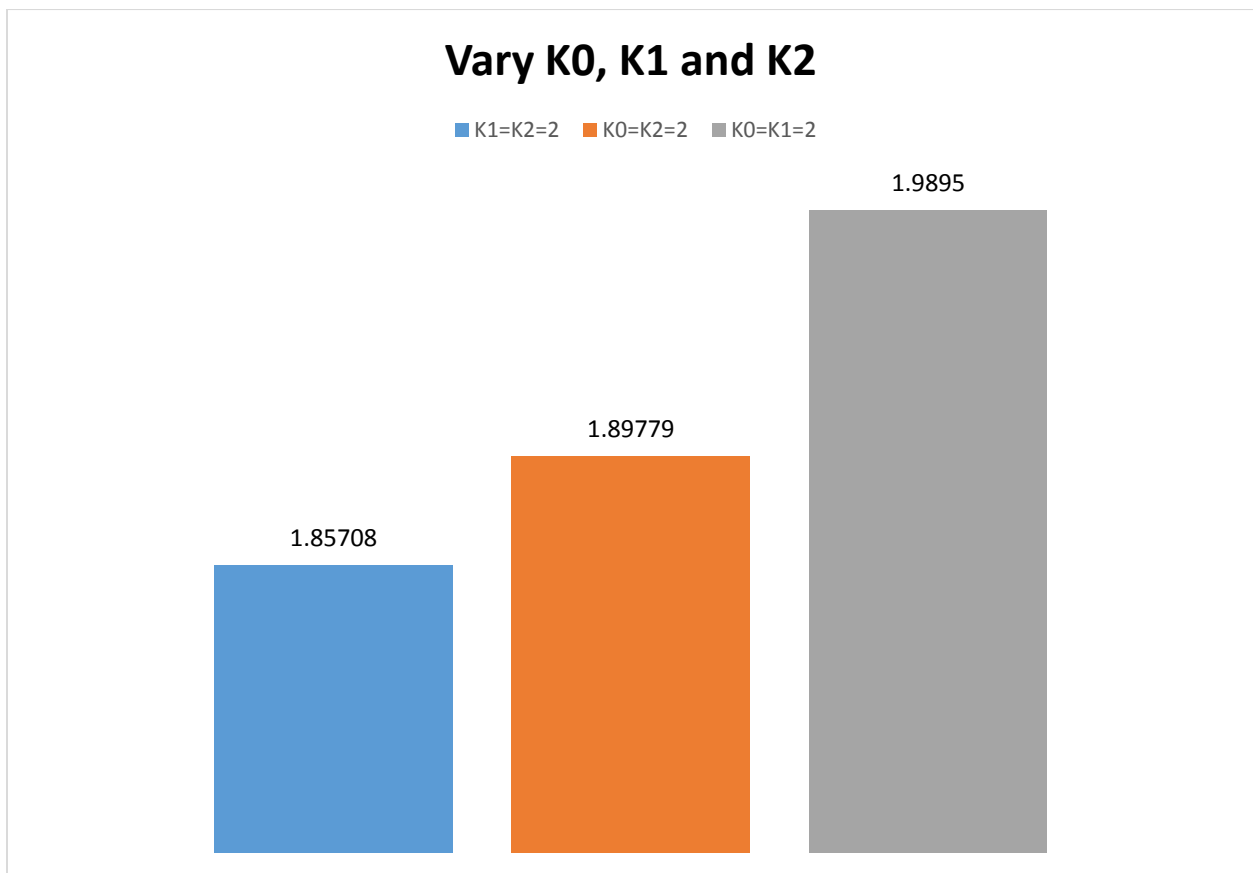
R	K0	K1	K2	F	Trace	IPC
6	2	2	2	4	mcf	2.36944
6	2	2	2	8	mcf	2.36944

$$IPC_{\max} = 2.36944$$

Thus, target $IPC > 0.95 * IPC_{\max} > 2.250968$

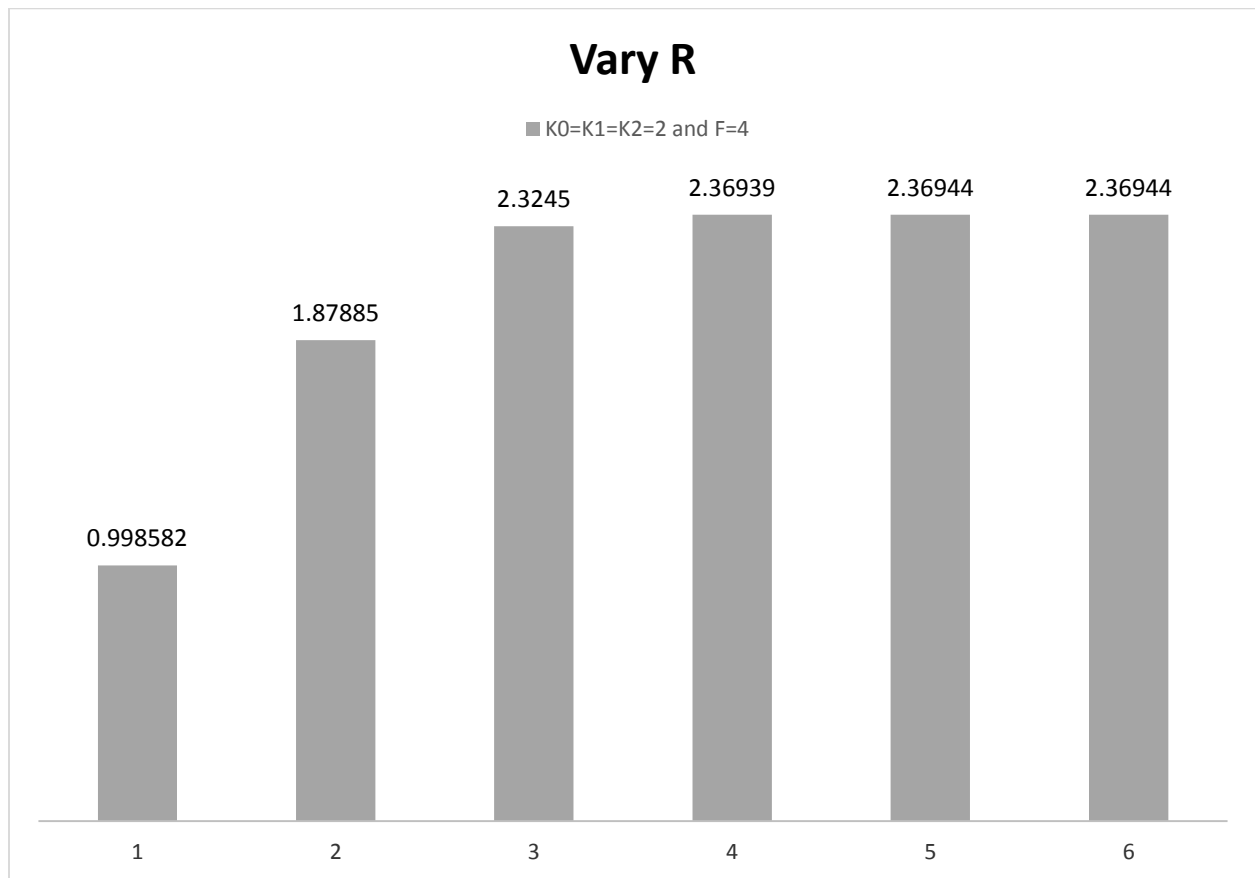
Set $R=5$, $F=4$.

- With $K1=K2=2$ and $K0=1$
- With $K0=K2=2$ and $K1=1$
- With $K0=K1=2$ and $K2=1$



From the graph we can observe that when either $K0$ or $K1$ or $K2$ is reduced to 1 we get $IPC < 2.250968$. Thus, we need to set $K0=K1=K2=2$.

Set $K_0=K_1=K_2=2$ and $F=4$. Vary R .



Thus, $K_0=K_1=K_2=2$, $R=3$ and $F=4$ is the configuration needed that gives IPC of 2.3245