Software-controlled conveyor belt

Abstract

Document includes solution for creating task, project summary, resource scheduling, over-allocation and Gantt chart view for Software-controlled conveyor belt project management

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Project Description

The new software-controlled conveyor belt is an exciting project that moves and positions items on a conveyor belt with a high degree of accuracy (< 1 millimeter of error). The proposed project will produce a new system capable of automating the movement of a wide variety of warehouse materials commonly used in order fulfillment. The following information has been developed for you to use in completing the exercises.

Assumptions and Notes

A seven-day workweek is used for the whole year. No holidays.
An 8-hour workday or 56-hour workweek is used. Overtime is not allowed.
The project should start on January 1 of the next year.
No splitting of activities is allowed.
No partial assignments are allowed (i.e. 50%). All resources must be assigned 100%.
Resources of a particular type have identical capabilities and may be substituted for each other. Hence, when working with resource type having multiple people, please create a single project resource listing (e.g. "Design") and assign the resource a percentage value corresponding to the number of people (e.g. 200% for two people). Similarly, when working with resource types having a single person, create a single project resource listing and assign it a value of 100% to indicate a single person.
Activity durations are fixed meaning adding resources to an activity does not decrease the duration of the activity.

Warning: Save your work frequently and make backup files as you answer each part.

Table 1

Activity	Description	Resource Type	Duration (days)	Preceding Activity
1	System architecture	Design	40	-
2	Hardware specifications	Development, design	50	1
3	Kernel specifications	Design	20	1
4	Utilities Specification	Development, design	25	1
5	Hardware Design	Design, development	70	2
6	Disk drivers	Assembly, development	95	3
7	Memory management	Development	75	3
8	Operating system documentation	Design, documentation	15	3
9	Routine utilities	Development	55	4
10	Complex utilities	Development	85	4
11	Utilities documentation	Documentation, design	10	4
12	Hardware documentation	Documentation, design	10	5
13	Integration first phase	Assembly, development	40	6,7,8,9,10, 11,12
14	Prototypes	Assembly, development	60	13
15	Serial I/O drivers	Development	85	13
16	System hard/software test	Assembly	15	14, 15
17	Order printed circuit boards	Purchasing	5	16
18	Network interface	Development	20	16
19	Shell	Development	20	16
20	Project documentation	Documentation, development	30	16
21	Assemble preproduction	Assembly, development	20	17, lag 10 days*
22	Integrated acceptance test	Assembly, development	20	18, 19, 20, 21

* Task 21 cannot begin until 10 days after task 17 has been completed

Table 2

Resource Type	Number Available to Work on Project	Cost ($/hr)
Design	2	$175
Development	2	$115
Documentation	1	$75
Assembly/Test	1	$65
Purchasing	1	$55

Part 3 – Question 1

Do not include resource assignments in your answer to Question 1. Only include activities, activity durations and dependencies. When entering task information in Question 1, please make sure the schedule mode is set to "Manually Scheduled" instead of "Auto Scheduled" as in Figure 1. Schedule mode may be set using the "Task Information" dialog or via the "Manually Schedule" button on the "Task" ribbon. Also, please make sure the "Level Manually Scheduled Tasks" check box in the "Resource Leveling" dialog box is deselected as in Figure 2. Leveling options may be viewed using the "Leveling Options" button in the "Resource" ribbon. Both are the default settings in MS Project 2019; however, if you've used project for other purposes, the default settings may have been adjusted.

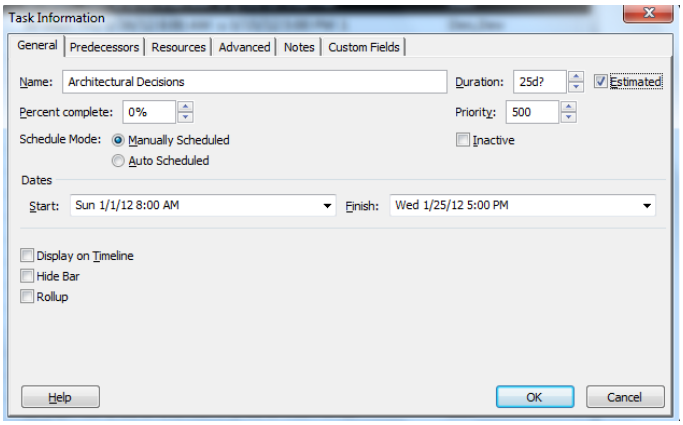


Figure 1 – Initial Task Information Dialog

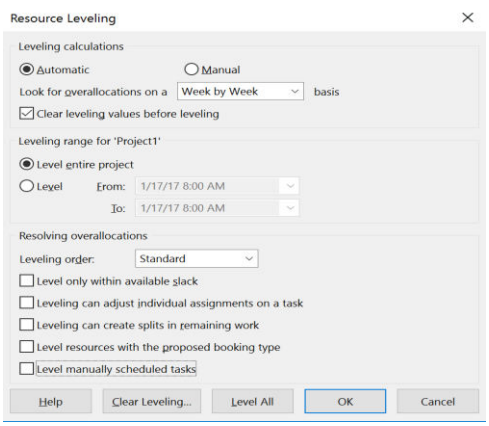
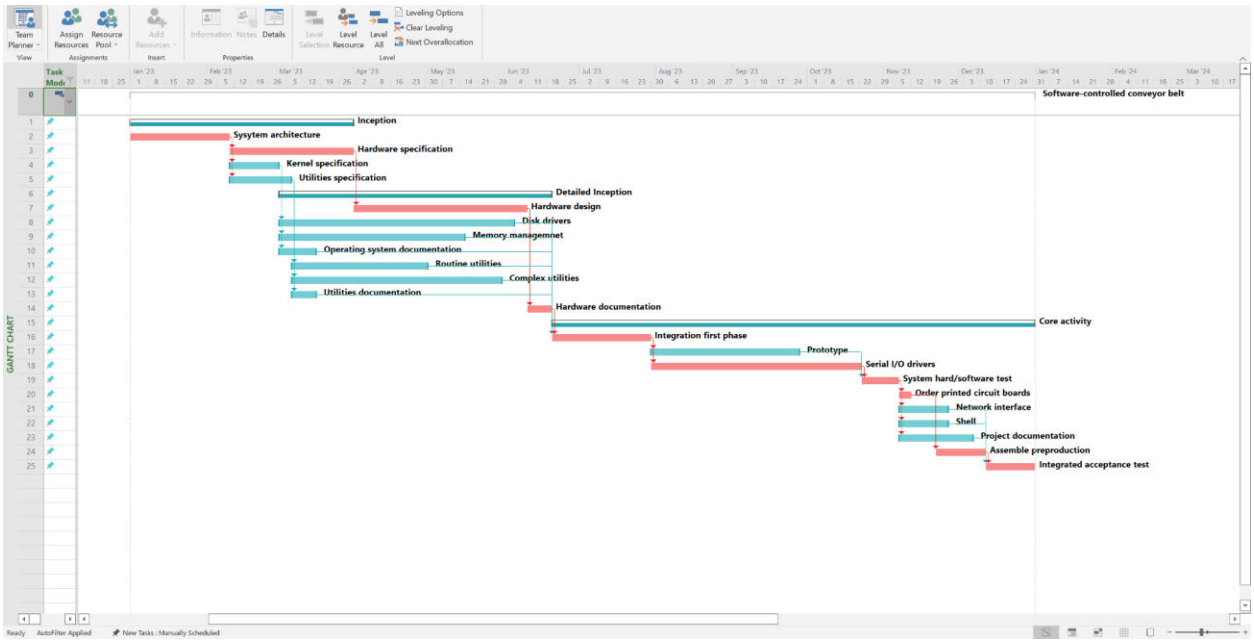


Figure 2 – Initial Resource Leveling Dialog

a. Create the project described in table 1 in Microsoft Project and paste a screenshot of the bar (Gantt) chart of the project highlighting the critical path below. Please make sure all tasks are clearly labeled with their corresponding task name. Your Gantt chart should also include a summary task. DO NOT INCLUDE THE RESOURCE ASSIGNMENTS LISTED IN THE THIRD COLUMN OF TABLE 1.



b. Include a screenshot out of early start, late start, early finish, late finish, total slack and free slack in table form. The screenshot provided should also include a summary task for the project.

	Task Mode	Task Name	Duration	Start	Finish	Early Start	Late Start	Early Finish	Late Finish	Total Slack	Free Slack
0		**Software-controlled conveyor belt**	**365 days**	**Sun 1/1/23**	**Sun 12/31/23**	**Sun 1/1/23**	**Sun 1/1/23**	**Sun 12/31/23**	**Sun 12/31/23**	**0 days**	**0 days**
1		**Inception**	**90 days**	**Sun 1/1/23**	**Fri 3/31/23**	**Sun 1/1/23**	**Sun 1/1/23**	**Fri 3/31/23**	**Fri 3/31/23**	**0 days**	**0 days**
2		Sysytem architecture	40 days	Sun 1/1/23	Thu 2/9/23	Sun 1/1/23	Sun 1/1/23	Thu 2/9/23	Fri 2/10/23	0 days	0 days
3		Hardware specification	50 days	Fri 2/10/23	Fri 3/31/23	Fri 2/10/23	Fri 2/10/23	Fri 3/31/23	Sat 4/1/23	0 days	0 days
4		Kernel specification	20 days	Fri 2/10/23	Wed 3/1/23	Fri 2/10/23	Sat 2/25/23	Wed 3/1/23	Fri 3/17/23	15 days	0 days
5		Utilities specification	25 days	Fri 2/10/23	Mon 3/6/23	Fri 2/10/23	Thu 3/2/23	Mon 3/6/23	Mon 3/27/23	20 days	0 days
6		**Detailed Inception**	**110 days**	**Thu 3/2/23**	**Mon 6/19/23**	**Thu 3/2/23**	**Thu 3/2/23**	**Mon 6/19/23**	**Mon 6/19/23**	**0 days**	**0 days**
7		Hardware design	70 days	Sat 4/1/23	Fri 6/9/23	Sat 4/1/23	Sat 4/1/23	Fri 6/9/23	Sat 6/10/23	0 days	0 days
8		Disk drivers	95 days	Thu 3/2/23	Sun 6/4/23	Thu 3/2/23	Fri 3/17/23	Sun 6/4/23	Tue 6/20/23	15 days	15 days
9		Memory managemnet	75 days	Thu 3/2/23	Mon 5/15/23	Thu 3/2/23	Thu 4/6/23	Mon 5/15/23	Tue 6/20/23	35 days	35 days
10		Operating system documentati	15 days	Thu 3/2/23	Thu 3/16/23	Thu 3/2/23	Mon 6/5/23	Thu 3/16/23	Tue 6/20/23	95 days	95 days
11		Routine utilities	55 days	Tue 3/7/23	Sun 4/30/23	Tue 3/7/23	Wed 4/26/23	Sun 4/30/23	Tue 6/20/23	50 days	50 days
12		Complex utilities	85 days	Tue 3/7/23	Tue 5/30/23	Tue 3/7/23	Mon 3/27/23	Tue 5/30/23	Tue 6/20/23	20 days	20 days
13		Utilities documentation	10 days	Tue 3/7/23	Thu 3/16/23	Tue 3/7/23	Sat 6/10/23	Thu 3/16/23	Tue 6/20/23	95 days	95 days
14		Hardware documentation	10 days	Sat 6/10/23	Mon 6/19/23	Sat 6/10/23	Sat 6/10/23	Mon 6/19/23	Tue 6/20/23	0 days	0 days
15		**Core activity**	**195 days**	**Tue 6/20/23**	**Sun 12/31/23**	**Tue 6/20/23**	**Tue 6/20/23**	**Sun 12/31/23**	**Sun 12/31/23**	**0 days**	**0 days**
16		Integration first phase	40 days	Tue 6/20/23	Sat 7/29/23	Tue 6/20/23	Tue 6/20/23	Sat 7/29/23	Sun 7/30/23	0 days	0 days
17		Prototype	60 days	Sun 7/30/23	Wed 9/27/23	Sun 7/30/23	Thu 8/24/23	Wed 9/27/23	Mon 10/23/23	25 days	25 days
18		Serial I/O drivers	85 days	Sun 7/30/23	Sun 10/22/23	Sun 7/30/23	Sun 7/30/23	Sun 10/22/23	Mon 10/23/23	0 days	0 days
19		System hard/software test	15 days	Mon 10/23/2	Mon 11/6/23	Mon 10/23/23	Mon 10/23/23	Mon 11/6/23	Tue 11/7/23	0 days	0 days
20		Order printed circuit boards	5 days	Tue 11/7/23	Sat 11/11/23	Tue 11/7/23	Tue 11/7/23	Sat 11/11/23	Sun 11/12/23	0 days	0 days
21		Network interface	20 days	Tue 11/7/23	Sun 11/26/23	Tue 11/7/23	Wed 11/22/23	Sun 11/26/23	Tue 12/12/23	15 days	15 days
22		Shell	20 days	Tue 11/7/23	Sun 11/26/23	Tue 11/7/23	Wed 11/22/23	Sun 11/26/23	Tue 12/12/23	15 days	15 days
23		Project documentation	30 days	Tue 11/7/23	Wed 12/6/23	Tue 11/7/23	Sun 11/12/23	Wed 12/6/23	Tue 12/12/23	5 days	5 days
24		Assemble preproduction	20 days	Wed 11/22/2	Mon 12/11/23	Wed 11/22/23	Wed 11/22/23	Mon 12/11/23	Tue 12/12/23	0 days	0 days
25		Integrated acceptance test	20 days	Tue 12/12/23	Sun 12/31/23	Tue 12/12/23	Tue 12/12/23	Sun 12/31/23	Sun 12/31/23	0 days	0 days

c. What is the scheduled finish date?

- **The scheduled finish date is 12/31/23**

d. How many days will the project take to complete?

- **The project will take 365 days to complete**

e. What percent of project activities are on the critical path?

- **10 out of 22 tasks(project activities) are on critical path which contributes to 45.45% (approx.45%)**

f. What activity has the most total slack? What activity has the most free slack? Explain the difference between free slack and total slack.

Referring to screenshot in question 1(b)

- **Operating system documentation and Utilities documentation have the most total slack of 95 days.**
- **Operating system documentation and Utilities documentation have the most free slack of 95 days.**
  Free Slack is the number of days that an activity can be delayed without delaying the early start of any immediate successor activity.
  Total Slack is the number of days that an activity can be delayed without delaying the whole project.

g. What is the total slack for the project as a whole? Use the summary task to help answer this question. Project summary task

- **Referring to screenshot in question 1(b), the total slack for the whole project is 0 days as indicated by the project summary task.**

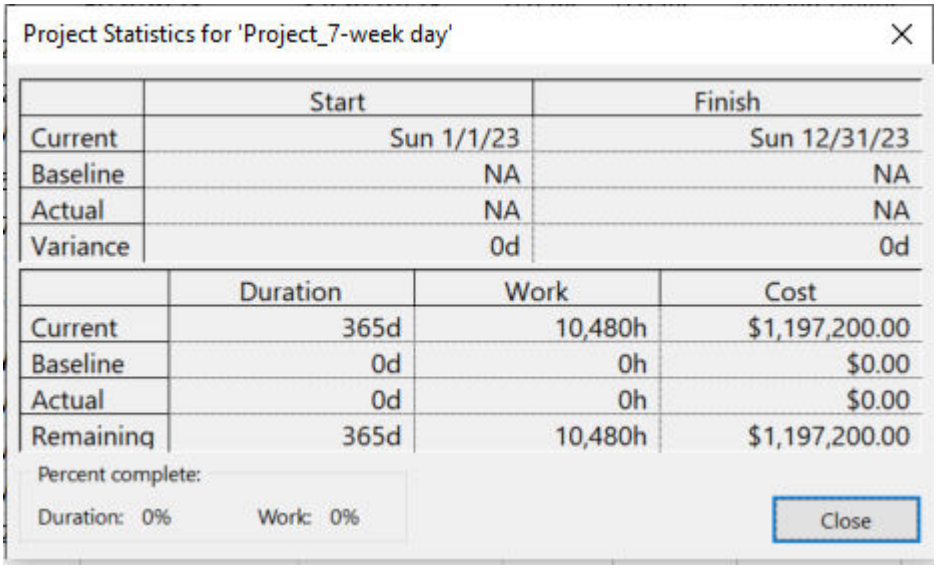
h. Is it better to have a higher percentage of activities on the critical path or a lower percentage of activities on the critical path? Explain your answer.

- **Having a lower percentage of activities on the critical path is preferred. The critical path outlines the longest distance between the start and end of the project which includes all the tasks, resources and activities that must be completed to finish the project on time. Higher the percentage of activities on critical path, higher the chance of delaying the project.**

Part 3 Question 2

Using the project you created in question 1, assign resources to perform each activity. The project is limited to the resources listed in Table 2. All scheduled activities must include a list of resource commitments.

a. After assigning resources, what is the cost of the project?



Project Statistics for 'Project_7-week day'

	Start	Finish
Current	Sun 1/1/23	Sun 12/31/23
Baseline	NA	NA
Actual	NA	NA
Variance	0d	0d

	Duration	Work	Cost
Current	365d	10,480h	$1,197,200.00
Baseline	0d	0h	$0.00
Actual	0d	0h	$0.00
Remaining	365d	10,480h	$1,197,200.00

Percent complete:
Duration: 0% Work: 0%

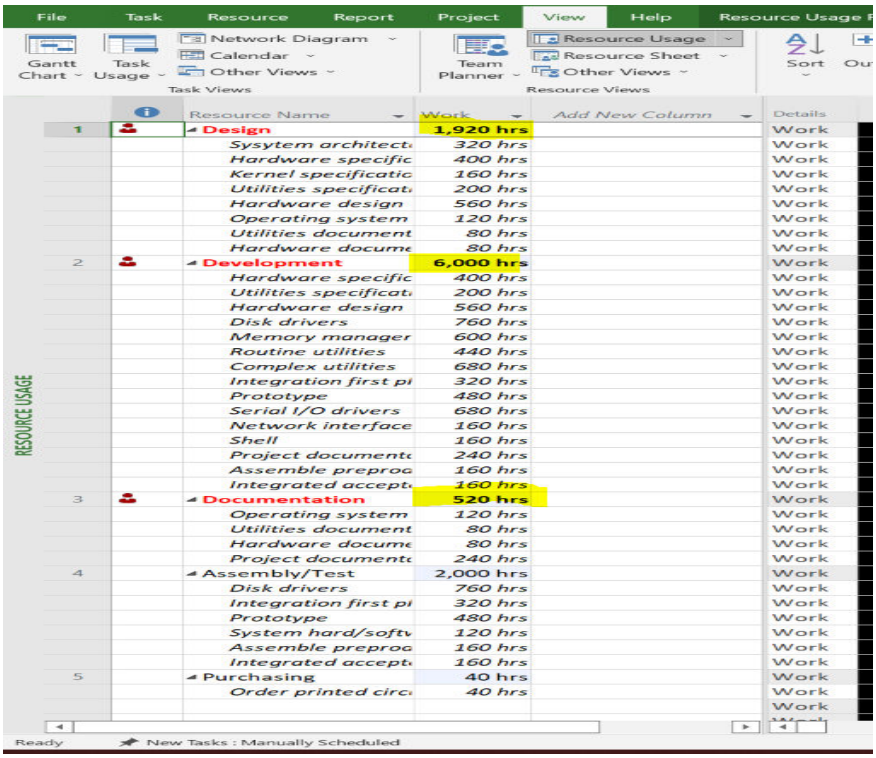
Close

- **$1,197,200.00 is the overall cost of the project after assigning resources.**

b. Which, if any, of the resources are over-allocated? List the resources that are over-allocated.

Three resources are over-allocated.

- **Design**
- **Development**
- **Documentation**



c. Try to resolve the over-allocation problems without extending the duration of the project using the resource leveling feature of MS Project. To level resources without extending the duration of the project, make sure the check boxes for "Level only within available slack" and "Level manually scheduled tasks" are both selected. Also, assume "Leveling can adjust individual assignments on task", "Leveling can create splits in remaining work", and "Level resources with the proposed booking type" are deselected. See Figure 3 for the correct leveling settings? Which, if any, of the over-allocated resources are no longer over-allocated? Which, if any, of the resources are still over-allocated?

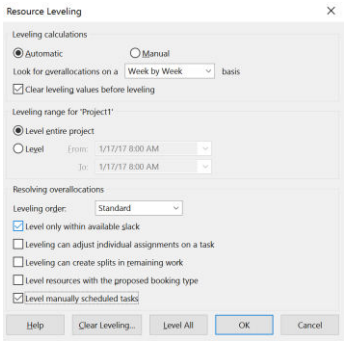
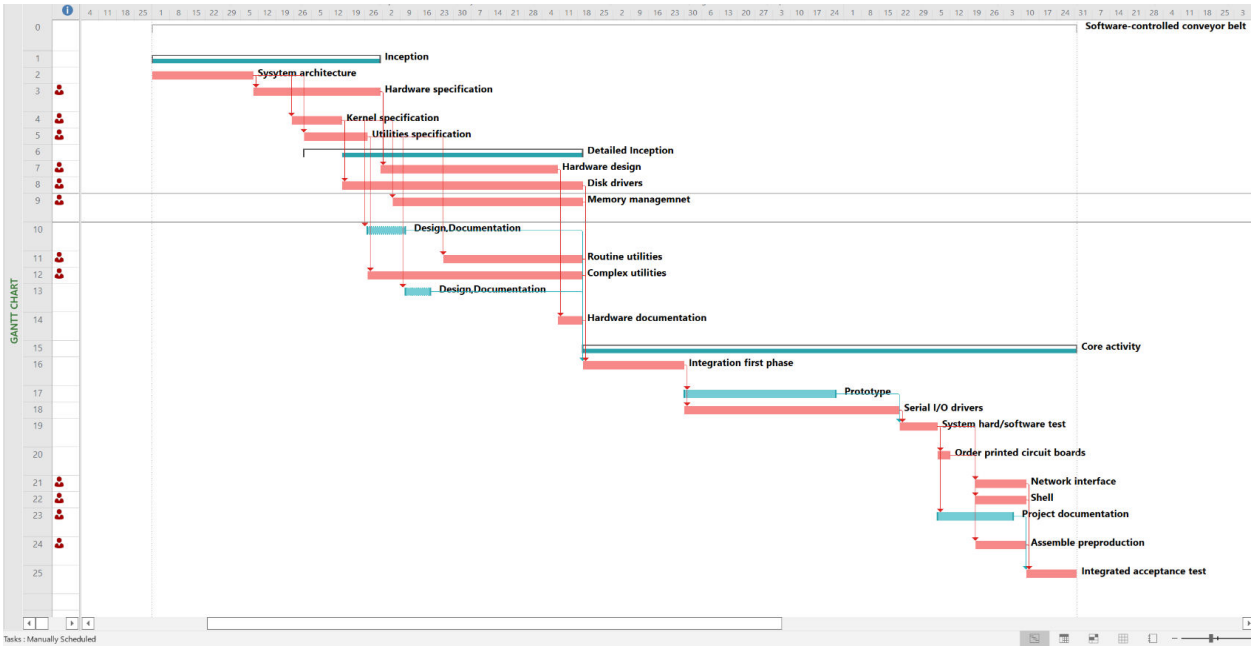


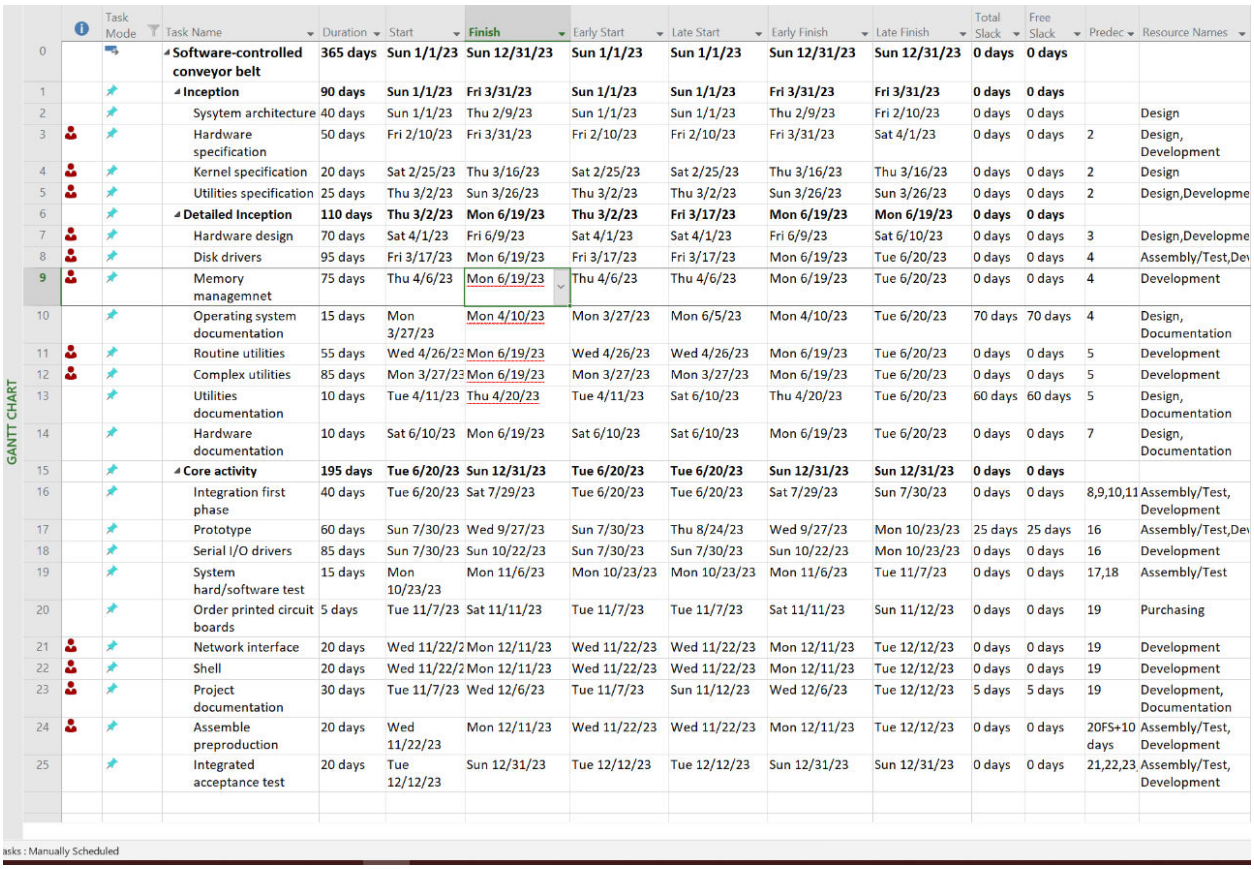
Figure 3 – Resource Leveling Dialog for question 2b

- **After updating settings as in Figure 3, the resource Documentation is no longer over-allocated. However, the resources Design and Development are still over-allocated.**

		Resource Name	Work	Add New Column
2		Design	1,920 hrs	
		Sysytem architecti	320 hrs	
		Hardware specific	400 hrs	
		Kernel specificatic	160 hrs	
		Utilities specificati	200 hrs	
		Hardware design	560 hrs	
		Operating system	120 hrs	
		Utilities document	80 hrs	
		Hardware docume	80 hrs	
3		Development	6,000 hrs	
		Hardware specific	400 hrs	
		Utilities specificati	200 hrs	
		Hardware design	560 hrs	
		Disk drivers	760 hrs	
		Memory manager	600 hrs	
		Routine utilities	440 hrs	
		Complex utilities	680 hrs	
		Integration first pl	320 hrs	
		Prototype	480 hrs	
		Serial I/O drivers	680 hrs	
		Network interface	160 hrs	
		Shell	160 hrs	
		Project documente	240 hrs	
		Assemble preproa	160 hrs	
		Integrated accepti	160 hrs	
4		Documentation	520 hrs	
		Operating system	120 hrs	
		Utilities document	80 hrs	
		Hardware docume	80 hrs	
		Project documente	240 hrs	
5		Assembly/Test	2,000 hrs	
		Disk drivers	760 hrs	
		Integration first pl	320 hrs	
		Prototype	480 hrs	
		System hard/softv	120 hrs	
		Assemble preproa	160 hrs	
		Integrated accepti	160 hrs	
6		Purchasing	40 hrs	
		Order printed circi	40 hrs	

d. Include a Gantt chart and schedule table after leveling only within available slack. Please include a summary task and make sure all tasks are clearly labeled with their corresponding task name.





	Task Mode	Task Name	Duration	Start	Finish	Early Start	Late Start	Early Finish	Late Finish	Total Slack	Free Slack	Predec	Resource Names
0		**Software-controlled conveyor belt**	**365 days**	**Sun 1/1/23**	**Sun 12/31/23**	**Sun 1/1/23**	**Sun 1/1/23**	**Sun 12/31/23**	**Sun 12/31/23**	**0 days**	**0 days**		
1		**Inception**	**90 days**	**Sun 1/1/23**	**Fri 3/31/23**	**Sun 1/1/23**	**Sun 1/1/23**	**Fri 3/31/23**	**Fri 3/31/23**	**0 days**	**0 days**		
2		Sysytem architecture	40 days	Sun 1/1/23	Thu 2/9/23	Sun 1/1/23	Sun 1/1/23	Thu 2/9/23	Fri 2/10/23	0 days	0 days		Design
3		Hardware specification	50 days	Fri 2/10/23	Fri 3/31/23	Fri 2/10/23	Fri 2/10/23	Fri 3/31/23	Sat 4/1/23	0 days	0 days	2	Design, Development
4		Kernel specification	20 days	Sat 2/25/23	Thu 3/16/23	Sat 2/25/23	Sat 2/25/23	Thu 3/16/23	Thu 3/16/23	0 days	0 days	2	Design
5		Utilities specification	25 days	Thu 3/2/23	Sun 3/26/23	Thu 3/2/23	Thu 3/2/23	Sun 3/26/23	Sun 3/26/23	0 days	0 days	2	Design,Developme
6		**Detailed Inception**	**110 days**	**Thu 3/2/23**	**Mon 6/19/23**	**Thu 3/2/23**	**Fri 3/17/23**	**Mon 6/19/23**	**Mon 6/19/23**	**0 days**	**0 days**		
7		Hardware design	70 days	Sat 4/1/23	Fri 6/9/23	Sat 4/1/23	Sat 4/1/23	Fri 6/9/23	Sat 6/10/23	0 days	0 days	3	Design,Developme
8		Disk drivers	95 days	Fri 3/17/23	Mon 6/19/23	Fri 3/17/23	Fri 3/17/23	Mon 6/19/23	Tue 6/20/23	0 days	0 days	4	Assembly/Test,Dev
9		Memory managemnet	75 days	Thu 4/6/23	Mon 6/19/23	Thu 4/6/23	Thu 4/6/23	Mon 6/19/23	Tue 6/20/23	0 days	0 days	4	Development
10		Operating system documentation	15 days	Mon 3/27/23	Mon 4/10/23	Mon 3/27/23	Mon 6/5/23	Mon 4/10/23	Tue 6/20/23	70 days	70 days	4	Design, Documentation
11		Routine utilities	55 days	Wed 4/26/23	Mon 6/19/23	Wed 4/26/23	Wed 4/26/23	Mon 6/19/23	Tue 6/20/23	0 days	0 days	5	Development
12		Complex utilities	85 days	Mon 3/27/23	Mon 6/19/23	Mon 3/27/23	Mon 3/27/23	Mon 6/19/23	Tue 6/20/23	0 days	0 days	5	Development
13		Utilities documentation	10 days	Tue 4/11/23	Thu 4/20/23	Tue 4/11/23	Sat 6/10/23	Thu 4/20/23	Tue 6/20/23	60 days	60 days	5	Design, Documentation
14		Hardware documentation	10 days	Sat 6/10/23	Mon 6/19/23	Sat 6/10/23	Sat 6/10/23	Mon 6/19/23	Tue 6/20/23	0 days	0 days	7	Design, Documentation
15		**Core activity**	**195 days**	**Tue 6/20/23**	**Sun 12/31/23**	**Tue 6/20/23**	**Tue 6/20/23**	**Sun 12/31/23**	**Sun 12/31/23**	**0 days**	**0 days**		
16		Integration first phase	40 days	Tue 6/20/23	Sat 7/29/23	Tue 6/20/23	Tue 6/20/23	Sat 7/29/23	Sun 7/30/23	0 days	0 days	8,9,10,11	Assembly/Test, Development
17		Prototype	60 days	Sun 7/30/23	Wed 9/27/23	Sun 7/30/23	Thu 8/24/23	Wed 9/27/23	Mon 10/23/23	25 days	25 days	16	Assembly/Test,Dev
18		Serial I/O drivers	85 days	Sun 7/30/23	Sun 10/22/23	Sun 7/30/23	Sun 7/30/23	Sun 10/22/23	Mon 10/23/23	0 days	0 days	16	Development
19		System hard/software test	15 days	Mon 10/23/23	Mon 11/6/23	Mon 10/23/23	Mon 10/23/23	Mon 11/6/23	Tue 11/7/23	0 days	0 days	17,18	Assembly/Test
20		Order printed circuit boards	5 days	Tue 11/7/23	Sat 11/11/23	Tue 11/7/23	Tue 11/7/23	Sat 11/11/23	Sun 11/12/23	0 days	0 days	19	Purchasing
21		Network interface	20 days	Wed 11/22/2	Mon 12/11/23	Wed 11/22/23	Wed 11/22/23	Mon 12/11/23	Tue 12/12/23	0 days	0 days	19	Development
22		Shell	20 days	Wed 11/22/2	Mon 12/11/23	Wed 11/22/23	Wed 11/22/23	Mon 12/11/23	Tue 12/12/23	0 days	0 days	19	Development
23		Project documentation	30 days	Tue 11/7/23	Wed 12/6/23	Tue 11/7/23	Sun 11/12/23	Wed 12/6/23	Tue 12/12/23	5 days	5 days	19	Development, Documentation
24		Assemble preproduction	20 days	Wed 11/22/23	Mon 12/11/23	Wed 11/22/23	Wed 11/22/23	Mon 12/11/23	Tue 12/12/23	0 days	0 days	20FS+10 days	Assembly/Test, Development
25		Integrated acceptance test	20 days	Tue 12/12/23	Sun 12/31/23	Tue 12/12/23	Tue 12/12/23	Sun 12/31/23	Sun 12/31/23	0 days	0 days	21,22,23	Assembly/Test, Development

GANTT CHART

asks : Manually Scheduled

Schedule table

e. What is the impact of leveling within slack on the percent of project activities on the critical path?

- **After leveling all allocated resources within slack, the percentage of activities on the critical path increased. The original critical path without resource allocation was about 45.45% (approx. 45%). After leveling, the critical path has increased to 18 tasks out of 22 total tasks, which sits at about 81.81% (approx. 82%). That is a 36.36% (approx. 36%) difference.**

f. Assume you cannot add additional resources and the project is resource constrained. How many days will the project take after resolving all over-allocation problems? What is the scheduled finish date?

See Figure 4 for the correct leveling settings. After leveling your project, change the scheduling mode for all tasks to "Auto Schedule" as in Figure 5 and review all tasks in the project to ensure no problems exist.

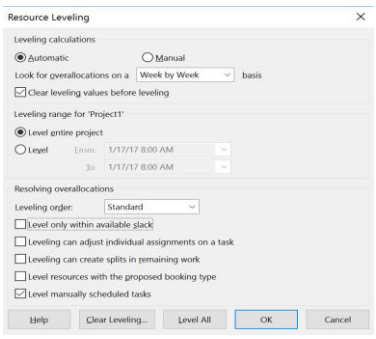


Figure 4 – Resource Leveling Dialog for Question 2e

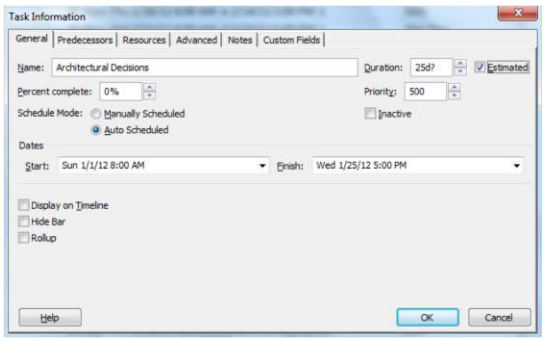
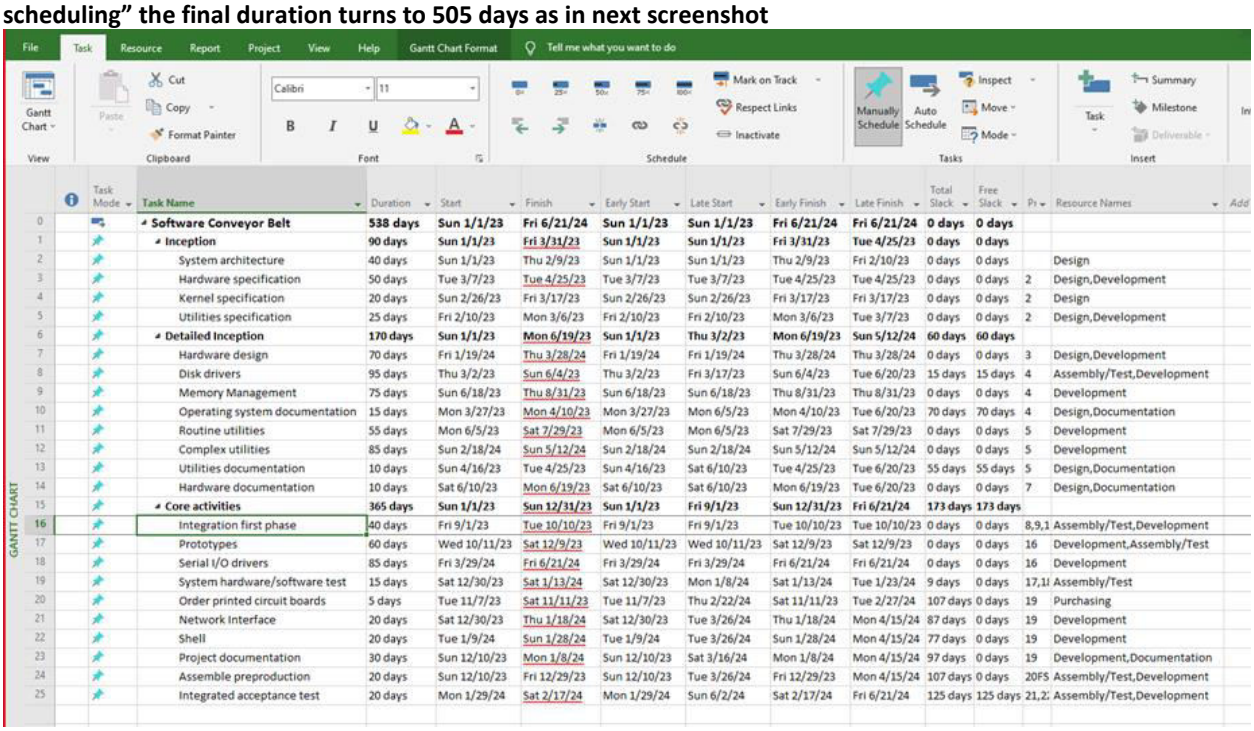


Figure 5 – Task Information Dialog for Question 2e

- **After changing the Leveling Options by unchecking "Level only within available slack" and the scheduling mode with "Manual", we get 538 days. However, after changing scheduling mode to "Auto scheduling" the final duration turns to 505 days as in next screenshot**



	Task Mode	Task Name	Duration	Start	Finish	Early Start	Late Start	Early Finish	Late Finish	Total Slack	Free Slack	Pr	Resource Names
0		**Software Conveyor Belt**	**538 days**	**Sun 1/1/23**	**Fri 6/21/24**	**Sun 1/1/23**	**Sun 1/1/23**	**Fri 6/21/24**	**Fri 6/21/24**	**0 days**	**0 days**		
1		**Inception**	**90 days**	**Sun 1/1/23**	**Fri 3/31/23**	**Sun 1/1/23**	**Sun 1/1/23**	**Fri 3/31/23**	**Tue 4/25/23**	**0 days**	**0 days**		
2		System architecture	40 days	Sun 1/1/23	Thu 2/9/23	Sun 1/1/23	Sun 1/1/23	Thu 2/9/23	Fri 2/10/23	0 days	0 days		Design
3		Hardware specification	50 days	Tue 3/7/23	Tue 4/25/23	Tue 3/7/23	Tue 3/7/23	Tue 4/25/23	Tue 4/25/23	0 days	0 days	2	Design,Development
4		Kernel specification	20 days	Sun 2/26/23	Fri 3/17/23	Sun 2/26/23	Sun 2/26/23	Fri 3/17/23	Fri 3/17/23	0 days	0 days	2	Design
5		Utilities specification	25 days	Fri 2/10/23	Mon 3/6/23	Fri 2/10/23	Fri 2/10/23	Mon 3/6/23	Tue 3/7/23	0 days	0 days	2	Design,Development
6		**Detailed Inception**	**170 days**	**Sun 1/1/23**	**Mon 6/19/23**	**Sun 1/1/23**	**Thu 3/2/23**	**Mon 6/19/23**	**Sun 5/12/24**	**60 days**	**60 days**		
7		Hardware design	70 days	Fri 1/19/24	Thu 3/28/24	Fri 1/19/24	Fri 1/19/24	Thu 3/28/24	Thu 3/28/24	0 days	0 days	3	Design,Development
8		Disk drivers	95 days	Thu 3/2/23	Sun 6/4/23	Thu 3/2/23	Fri 3/17/23	Sun 6/4/23	Tue 6/20/23	15 days	15 days	4	Assembly/Test,Development
9		Memory Management	75 days	Sun 6/18/23	Thu 8/31/23	Sun 6/18/23	Sun 6/18/23	Thu 8/31/23	Thu 8/31/23	0 days	0 days	4	Development
10		Operating system documentation	15 days	Mon 3/27/23	Mon 4/10/23	Mon 3/27/23	Mon 6/5/23	Mon 4/10/23	Tue 6/20/23	70 days	70 days	4	Design,Documentation
11		Routine utilities	55 days	Mon 6/5/23	Sat 7/29/23	Mon 6/5/23	Mon 6/5/23	Sat 7/29/23	Sat 7/29/23	0 days	0 days	5	Development
12		Complex utilities	85 days	Sun 2/18/24	Sun 5/12/24	Sun 2/18/24	Sun 2/18/24	Sun 5/12/24	Sun 5/12/24	0 days	0 days	5	Development
13		Utilities documentation	10 days	Sun 4/16/23	Tue 4/25/23	Sun 4/16/23	Sat 6/10/23	Tue 4/25/23	Tue 6/20/23	55 days	55 days	5	Design,Documentation
14		Hardware documentation	10 days	Sat 6/10/23	Mon 6/19/23	Sat 6/10/23	Sat 6/10/23	Mon 6/19/23	Tue 6/20/23	0 days	0 days	7	Design,Documentation
15		**Core activities**	**365 days**	**Sun 1/1/23**	**Sun 12/31/23**	**Sun 1/1/23**	**Fri 9/1/23**	**Sun 12/31/23**	**Fri 6/21/24**	**173 days**	**173 days**		
16		Integration first phase	40 days	Fri 9/1/23	Tue 10/10/23	Fri 9/1/23	Fri 9/1/23	Tue 10/10/23	Tue 10/10/23	0 days	0 days	8,9,1	Assembly/Test,Development
17		Prototypes	60 days	Wed 10/11/23	Sat 12/9/23	Wed 10/11/23	Wed 10/11/23	Sat 12/9/23	Sat 12/9/23	0 days	0 days	16	Development,Assembly/Test
18		Serial I/O drivers	85 days	Fri 3/29/24	Fri 6/21/24	Fri 3/29/24	Fri 3/29/24	Fri 6/21/24	Fri 6/21/24	0 days	0 days	16	Development
19		System hardware/software test	15 days	Sat 12/30/23	Sat 1/13/24	Sat 12/30/23	Mon 1/8/24	Sat 1/13/24	Tue 1/23/24	9 days	0 days	17,1	Assembly/Test
20		Order printed circuit boards	5 days	Tue 11/7/23	Sat 11/11/23	Tue 11/7/23	Thu 2/22/24	Sat 11/11/23	Tue 2/27/24	107 days	0 days	19	Purchasing
21		Network Interface	20 days	Sat 12/30/23	Thu 1/18/24	Sat 12/30/23	Tue 3/26/24	Thu 1/18/24	Mon 4/15/24	87 days	0 days	19	Development
22		Shell	20 days	Tue 1/9/24	Sun 1/28/24	Tue 1/9/24	Tue 3/26/24	Sun 1/28/24	Mon 4/15/24	77 days	0 days	19	Development
23		Project documentation	30 days	Sun 12/10/23	Mon 1/8/24	Sun 12/10/23	Sat 3/16/24	Mon 1/8/24	Mon 4/15/24	97 days	0 days	19	Development,Documentation
24		Assemble preproduction	20 days	Sun 12/10/23	Fri 12/29/23	Sun 12/10/23	Tue 3/26/24	Fri 12/29/23	Mon 4/15/24	107 days	0 days	20FS	Assembly/Test,Development
25		Integrated acceptance test	20 days	Mon 1/29/24	Sat 2/17/24	Mon 1/29/24	Sun 6/2/24	Sat 2/17/24	Fri 6/21/24	125 days	125 days	21,2	Assembly/Test,Development

- **After changing the Leveling Options by unchecking "Level only within available slack" and setting the scheduling mode to "Auto Schedule", the final project duration changed from 365 days to 505 days. In addition, the original finish date was 12/31/2023 and now the new finish date is 5/19/2024.**

	Task Mode	Task Name	Duration	Start	Finish	Early Start	Late Start	Early Finish	Late Finish	Total Slack	Free Slack	Predec	Resource Names
0		**Software-controlled conveyor belt**	**505 days**	**Sun 1/1/23**	**Sun 5/19/24**	**Sun 1/1/23**	**Sun 1/1/23**	**Sun 5/19/24**	**Sun 5/19/24**	**0 days**	**0 days**		
1		**Inception**	**95 days**	**Sun 1/1/23**	**Wed 4/5/23**	**Sun 1/1/23**	**Sun 1/1/23**	**Wed 4/5/23**	**Sat 7/29/23**	**0 days**	**0 days**		
2		Sysytem architecture	40 days	Sun 1/1/23	Thu 2/9/23	Sun 1/1/23	Sun 1/1/23	Thu 2/9/23	Thu 2/9/23	0 days	0 days		Design
3		Hardware specification	50 days	Fri 2/10/23	Fri 3/31/23	Fri 2/10/23	Sat 6/10/23	Fri 3/31/23	Sat 7/29/23	120 days	0 days	2	Design, Development
4		Kernel specification	20 days	Fri 3/17/23	Wed 4/5/23	Fri 2/10/23	Thu 5/11/23	Wed 4/5/23	Tue 5/30/23	55 days	0 days	2	Design
5		Utilities specification	25 days	Fri 2/10/23	Mon 3/6/23	Fri 2/10/23	Fri 2/10/23	Mon 3/6/23	Mon 3/6/23	0 days	0 days	2	Design,Developme
6		**Detailed Inception**	**225 days**	**Tue 3/7/23**	**Tue 10/17/23**	**Tue 3/7/23**	**Sat 7/15/23**	**Tue 10/17/23**	**Tue 10/17/23**	**0 days**	**0 days**		
7		Hardware design	70 days	Sat 4/1/23	Fri 6/9/23	Sat 4/1/23	Sun 7/30/23	Fri 6/9/23	Sat 10/7/23	120 days	0 days	3	Design,Developme
8		Disk drivers	95 days	Thu 4/6/23	Sun 7/9/23	Thu 4/6/23	Sat 7/15/23	Sun 7/9/23	Tue 10/17/23	100 days	100 days	4	Assembly/Test,Dev
9		Memory managemnet	75 days	Sat 6/10/23	Wed 8/23/23	Thu 4/6/23	Fri 8/4/23	Wed 8/23/23	Tue 10/17/23	55 days	55 days	4	Development
10		Operating system documentation	15 days	Thu 4/6/23	Thu 4/20/23	Thu 4/6/23	Tue 10/3/23	Thu 4/20/23	Tue 10/17/23	180 days	180 days	4	Design, Documentation
11		Routine utilities	55 days	Thu 8/24/23	Tue 10/17/23	Tue 3/7/23	Thu 8/24/23	Tue 10/17/23	Tue 10/17/23	0 days	0 days	5	Development
12		Complex utilities	85 days	Mon 7/10/23	Mon 10/2/23	Tue 3/7/23	Tue 7/25/23	Mon 10/2/23	Tue 10/17/23	15 days	15 days	5	Development
13		Utilities documentation	10 days	Tue 3/7/23	Thu 3/16/23	Tue 3/7/23	Sun 10/8/23	Thu 3/16/23	Tue 10/17/23	215 days	215 days	5	Design, Documentation
14		Hardware documentation	10 days	Sat 6/10/23	Mon 6/19/23	Sat 6/10/23	Sun 10/8/23	Mon 6/19/23	Tue 10/17/23	120 days	120 days	7	Design, Documentation
15		**Core activity**	**215 days**	**Wed 10/18/2**	**Sun 5/19/24**	**Wed 10/18/23**	**Wed 10/18/23**	**Sun 5/19/24**	**Sun 5/19/24**	**0 days**	**0 days**		
16		Integration first phase	40 days	Wed 10/18/23	Sun 11/26/23	Wed 10/18/23	Wed 10/18/23	Sun 11/26/23	Sun 11/26/23	0 days	0 days	8,9,10,11	Assembly/Test, Development
17		Prototype	60 days	Mon 11/27/2	Thu 1/25/24	Mon 11/27/23	Fri 12/22/23	Thu 1/25/24	Mon 2/19/24	25 days	25 days	16	Assembly/Test,Dev
18		Serial I/O drivers	85 days	Mon 11/27/2	Mon 2/19/24	Mon 11/27/23	Mon 11/27/23	Mon 2/19/24	Mon 2/19/24	0 days	0 days	16	Development
19		System hard/software test	15 days	Tue 2/20/24	Tue 3/5/24	Tue 2/20/24	Tue 2/20/24	Tue 3/5/24	Tue 3/5/24	0 days	0 days	17,18	Assembly/Test
20		Order printed circuit boards	5 days	Wed 3/6/24	Sun 3/10/24	Wed 3/6/24	Tue 3/26/24	Sun 3/10/24	Sat 3/30/24	20 days	0 days	19	Purchasing
21		Network interface	20 days	Fri 4/5/24	Wed 4/24/24	Wed 3/6/24	Wed 4/10/24	Wed 4/24/24	Mon 4/29/24	5 days	5 days	19	Development
22		Shell	20 days	Wed 4/10/24	Mon 4/29/24	Wed 3/6/24	Wed 4/10/24	Mon 4/29/24	Mon 4/29/24	0 days	0 days	19	Development
23		Project documentation	30 days	Wed 3/6/24	Thu 4/4/24	Wed 3/6/24	Sun 3/31/24	Thu 4/4/24	Mon 4/29/24	25 days	25 days	19	Development, Documentation
24		Assemble preproduction	20 days	Thu 3/21/24	Tue 4/9/24	Thu 3/21/24	Wed 4/10/24	Tue 4/9/24	Mon 4/29/24	20 days	20 days	20FS+10 days	Assembly/Test, Development
25		Integrated acceptance test	20 days	Tue 4/30/24	Sun 5/19/24	Tue 4/30/24	Tue 4/30/24	Sun 5/19/24	Sun 5/19/24	0 days	0 days	21,22,23	Assembly/Test, Development

g. How does the schedule in 2f compare to the schedule in Question 1? Why did the number of days to complete the project in 2f increase?

- **The schedule in 2f has more critical activities on its critical path compared to the schedule in Question 1. The duration has increased in 2f because there is a limited number of resources. Due to the limited number of resources, each resource is limited on their capacity to perform, which means it takes time for each resource to complete their tasks, further unchecking 'level only within available slack' had led to the increase of the Total Slack and the Free Slack for the activities .Hence, completion time of the project has increased by 140 days.**

h. What is the total cost of the project after resolving all over-allocation problems in step 2f? How does this cost compare with the cost in 2a?

- **The total cost of the project after resolving all over-allocation problems in step 2f remains unchanged. There is no change in the cost because the number of resources did not increase. By resolving the over-allocation issue, the project was able to properly address the tasks with the available fixed resources without overtime. However, as a side effect it increased the duration of the project.**

	Task Name	Fixed Cost	Fixed Cost Accrual	Total Cost	Baseline	Variance	Actual	Remaining	Add N
0	**Software-controlled conveyor belt**	**$0.00**	**Prorated**	**197,200.00**	**$0.00**	**,197,200.00**	**$0.00**	**197,200.00**	
1	**Inception**	**$0.00**	**Prorated**	**$258,000.00**	**$0.00**	**$258,000.00**	**$0.00**	**$258,000.00**	
2	Sysytem architecture	$0.00	Prorated	$56,000.00	$0.00	$56,000.00	$0.00	$56,000.00	
3	Hardware specification	$0.00	Prorated	$116,000.00	$0.00	$116,000.00	$0.00	$116,000.00	
4	Kernel specification	$0.00	Prorated	$28,000.00	$0.00	$28,000.00	$0.00	$28,000.00	
5	Utilities specification	$0.00	Prorated	$58,000.00	$0.00	$58,000.00	$0.00	$58,000.00	
6	**Detailed Inception**	**$0.00**	**Prorated**	**$567,000.00**	**$0.00**	**$567,000.00**	**$0.00**	**$567,000.00**	
7	Hardware design	$0.00	Prorated	$162,400.00	$0.00	$162,400.00	$0.00	$162,400.00	
8	Disk drivers	$0.00	Prorated	$136,800.00	$0.00	$136,800.00	$0.00	$136,800.00	
9	Memory managemnet	$0.00	Prorated	$69,000.00	$0.00	$69,000.00	$0.00	$69,000.00	
10	Operating system documentation	$0.00	Prorated	$30,000.00	$0.00	$30,000.00	$0.00	$30,000.00	
11	Routine utilities	$0.00	Prorated	$50,600.00	$0.00	$50,600.00	$0.00	$50,600.00	
12	Complex utilities	$0.00	Prorated	$78,200.00	$0.00	$78,200.00	$0.00	$78,200.00	
13	Utilities documentation	$0.00	Prorated	$20,000.00	$0.00	$20,000.00	$0.00	$20,000.00	
14	Hardware documentation	$0.00	Prorated	$20,000.00	$0.00	$20,000.00	$0.00	$20,000.00	
15	**Core activity**	**$0.00**	**Prorated**	**$372,200.00**	**$0.00**	**$372,200.00**	**$0.00**	**$372,200.00**	
16	Integration first phase	$0.00	Prorated	$57,600.00	$0.00	$57,600.00	$0.00	$57,600.00	
17	Prototype	$0.00	Prorated	$86,400.00	$0.00	$86,400.00	$0.00	$86,400.00	
18	Serial I/O drivers	$0.00	Prorated	$78,200.00	$0.00	$78,200.00	$0.00	$78,200.00	
19	System hard/software test	$0.00	Prorated	$7,800.00	$0.00	$7,800.00	$0.00	$7,800.00	
20	Order printed circuit boards	$0.00	Prorated	$2,200.00	$0.00	$2,200.00	$0.00	$2,200.00	
21	Network interface	$0.00	Prorated	$18,400.00	$0.00	$18,400.00	$0.00	$18,400.00	
22	Shell	$0.00	Prorated	$18,400.00	$0.00	$18,400.00	$0.00	$18,400.00	
23	Project documentation	$0.00	Prorated	$45,600.00	$0.00	$45,600.00	$0.00	$45,600.00	
24	Assemble preproduction	$0.00	Prorated	$28,800.00	$0.00	$28,800.00	$0.00	$28,800.00	
25	Integrated acceptance test	$0.00	Prorated	$28,800.00	$0.00	$28,800.00	$0.00	$28,800.00	

: Auto Scheduled

Project Statistics for 'Project_7-week day_question1b_final_new'

	Start	Finish
Current	Sun 1/1/23	Sun 5/19/24
Baseline	NA	NA
Actual	NA	NA
Variance	0d	0d

	Duration	Work	Cost
Current	505d	10,480h	$1,197,200.00
Baseline	0d	0h	$0.00
Actual	0d	0h	$0.00
Remaining	505d	10,480h	$1,197,200.00

Percent complete:

Duration: 0% Work: 0%

Close

Software-controlled conveyor belt

Abstract

Document includes use cases on compressing project duration, budget, utilizing more resources, overtime allocation and how it affects EV, PV, AC, BAC, EAC, ETAC, SPI, CPI and recommendations to get project back on track

Project Description

The new software-controlled conveyor belt is an exciting project that moves and positions items on a conveyor belt with a high degree of accuracy (< 1 millimeter of error). The proposed project will produce a new system capable of automating the movement of a wide variety of warehouse materials commonly used in order fulfillment. The following information has been developed for you to use in completing the exercises.

Assumptions and Notes

A seven-day workweek is used for the whole year. No holidays.
The project should start on January 1 of the next year.
Splitting activities is not allowed.
Resources have identical capabilities and may be substituted for each other. For example, an activity requiring a design resource may be performed by any of the design resources working on the project.
Activity durations are not fixed meaning adding resources to an activity decreases the duration of the activity.

Warning: Save your work frequently and make backup files as you answer each part.

You may be required to make additional assumptions to complete the assignment. If you do make an assumption, please clearly state the assumption and the reason for making it.

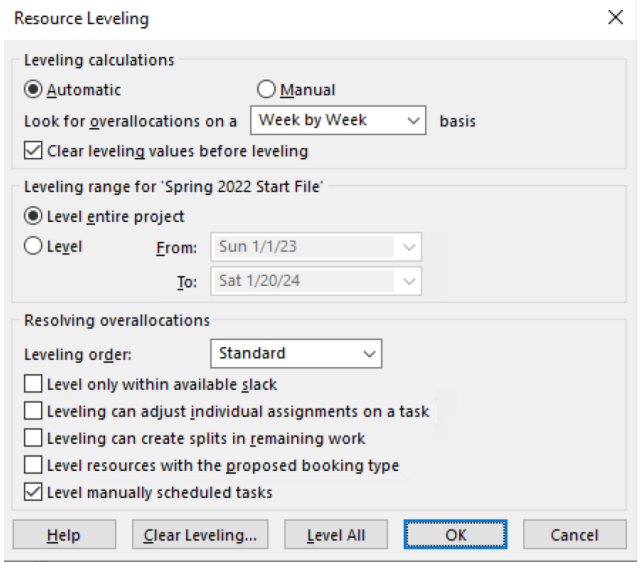
Question 1

This question is a continuation of the computer-controlled conveyor belt project begun in part 1. Use the included project START file to answer the following questions.

After showing your resource-constrained network to top management, they are very disappointed with the amount of time the project is scheduled to take. After some explanation and negotiation, they agree to assign **one additional Designer and three additional Developers** to the project team. The included MS Project START file has been updated to include the four additional resources and the project duration is now 365 days. ***Your task is to compress the schedule so that the project is completed in no more than 300 days.*** The following terms and conditions apply.

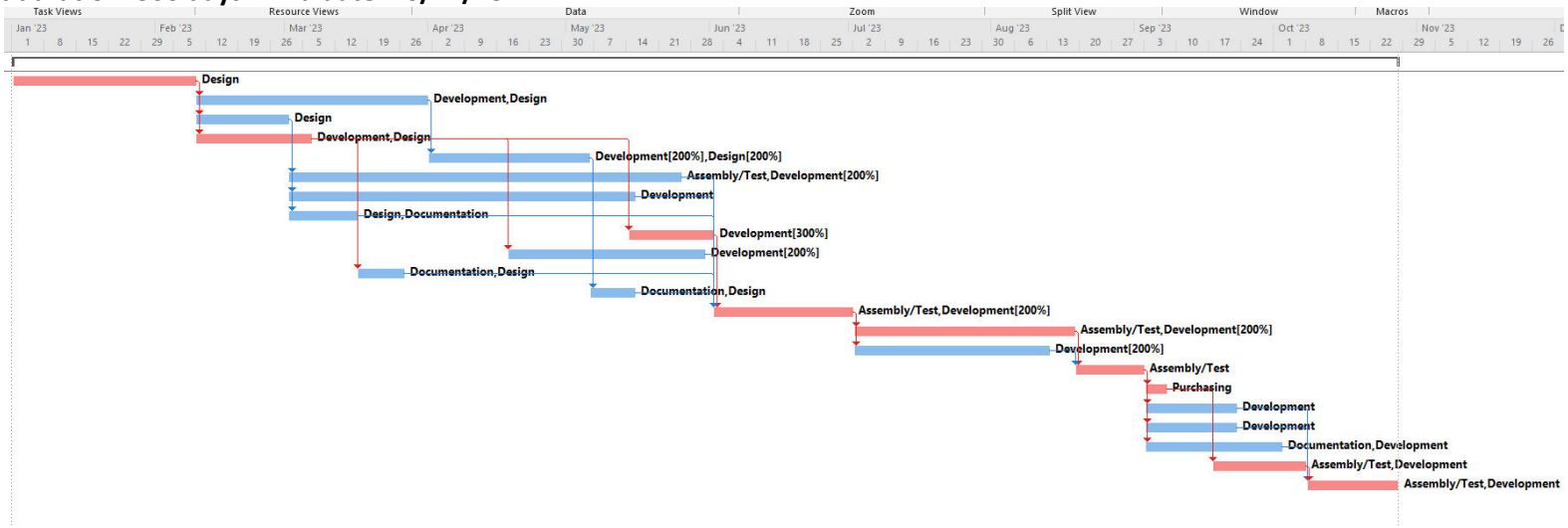
- You are **NOT allowed** to make any changes to tasks, 1, 2, 3, and 4.
- You may hire additional resources above and beyond what has already been assigned to the project, however, hire as few additional external people as possible because all external resources cost $50 more per hour than your inside people.
- Overtime is allowed, but the cost rate is 1.5 times the standard cost rate
- Splitting of tasks is NOT allowed
- Resources assignments less than 100% are allowed
- Reductions in project scope are NOT allowed
- ***Activity durations are not fixed meaning adding additional resources to an activity decreases the duration of the activity.***

Important Note: The Leveling Options dialog box settings are based on the settings used last on your computer instead of the settings contained in the project START file. When you first open the START file, your project completion date and/or duration may differ from others if you have different leveling options on your computer than what is listed below. To resolve this issue, please make sure your leveling options are as follows ***prior to opening the START file***. Changes to leveling options are not allowed and everyone should have the leveling options listed below.

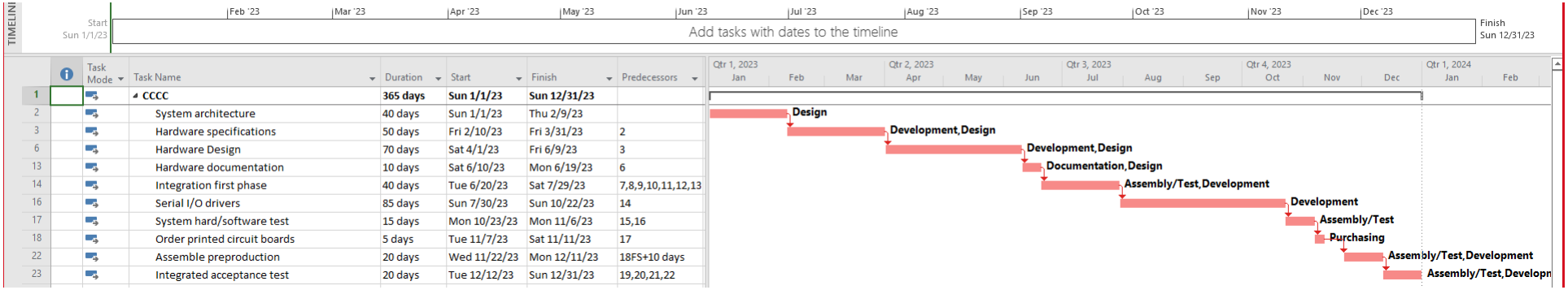


a. Include a screenshot of your final Gantt chart clearly identifying the critical path. What is the new finish time in number of days? What is the new finish date?

Project duration: 300 days End date: 10/27/23



b. List all of the changes you made to the original project schedule.



	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**CCCC**	**365 days**	**Sun 1/1/23**	**Sun 12/31/23**	
2		System architecture	40 days	Sun 1/1/23	Thu 2/9/23	
3		Hardware specifications	50 days	Fri 2/10/23	Fri 3/31/23	2
6		Hardware Design	70 days	Sat 4/1/23	Fri 6/9/23	3
13		Hardware documentation	10 days	Sat 6/10/23	Mon 6/19/23	6
14		Integration first phase	40 days	Tue 6/20/23	Sat 7/29/23	7,8,9,10,11,12,13
16		Serial I/O drivers	85 days	Sun 7/30/23	Sun 10/22/23	14
17		System hard/software test	15 days	Mon 10/23/23	Mon 11/6/23	15,16
18		Order printed circuit boards	5 days	Tue 11/7/23	Sat 11/11/23	17
22		Assemble preproduction	20 days	Wed 11/22/23	Mon 12/11/23	18FS+10 days
23		Integrated acceptance test	20 days	Tue 12/12/23	Sun 12/31/23	19,20,21,22

Assumptions/Strategy:

- Identified tasks on critical path to compress the duration by adding more design and development resources, as we now have 1 design and 3 development additional resources .Also, most of the tasks on critical path has design or development as resource. Modifying non-critical path tasks will not compress the overall project duration.
- Other observation is, the most tasks on critical path has assembly resource. Either we have to hire external resource or add overtime to bring down the duration of tasks on critical path that has assembly resource.
- Since hiring external resource costs $50 per hour more than the original cost/hr i.e., $65, if we decide to hire 1 external resource for assembly to work 8hrs/day for 10 days we end up paying **($65+$50) * (10days * 8 hr) =$9200** which is a lot compared to assigning overtime for existing resource which comes around **(1.5* $65) *(10 days *8 hr) = $7800** (from the data given : Overtime is allowed, but the cost rate is 1.5 times the standard cost rate).
- Assuming, consider the tasks that lasts for a month or more, assigning overtime of 80hrs for an existing resource is considerable without having to compromise on quality.
- If we have to bring down the project duration cost effectively i.e., with minimal budget overrun, we have to identify the resources from the tasks on critical path that has least cost/hr.

Steps:

Modified total of 7 tasks either by adding additional resources or by adding overtime

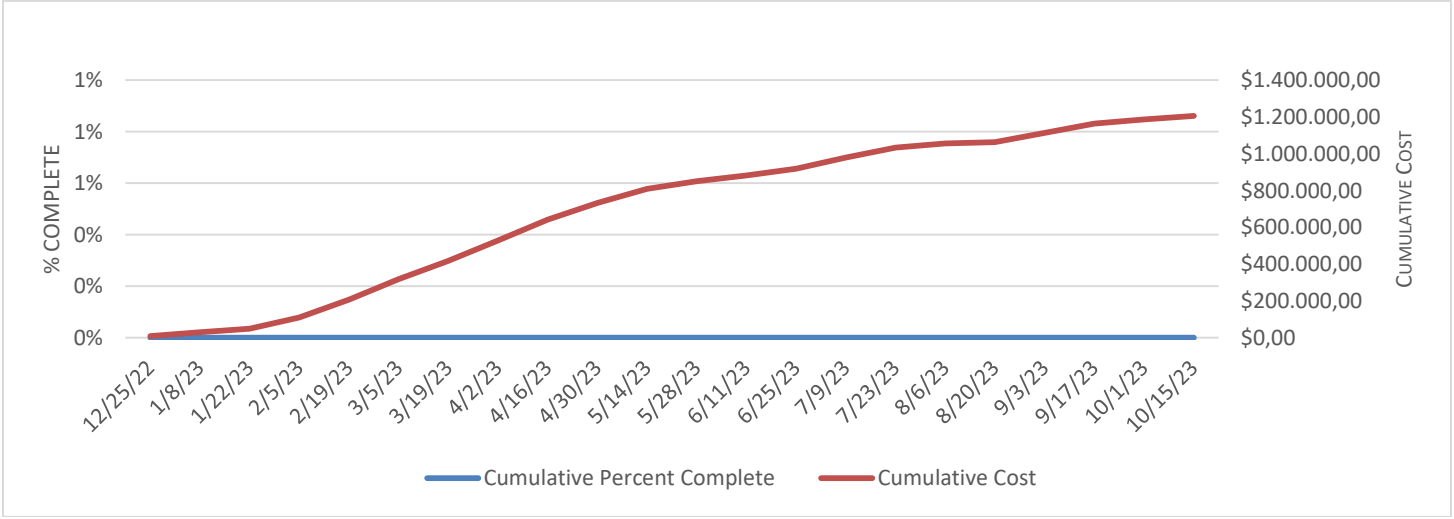
1. For the task **Hardware Design,** increased resource units from 100% to 200% each for **Development and Design.**
2. For the task **Disk Drivers,** increased resource units from 100% to 200% for **Development and added 80hr overtime for Assembly/Test.**
3. For the task **Routine Utilities,** increased resource units from 100% to 300% for **Development.**
4. For the task **Complex Utilities,** increased resource units from 100% to 200% for **Development.**
5. For the task **Integration Phase,** increased resource units from 100% to 200% for **Development and added 80hr overtime for Assembly/Test.**
6. For the task **Prototypes,** increased resource units from 100% to 200% for **Development and added 96hr overtime for Assembly/Test.**
7. For the task **Serial I/O Drivers,** increased resource units from 100% to 200% for **Development.**

Above modification to tasks has compressed the overall project duration from 365days to 300days.Also, tasks on critical path reduced from 10 to 9.

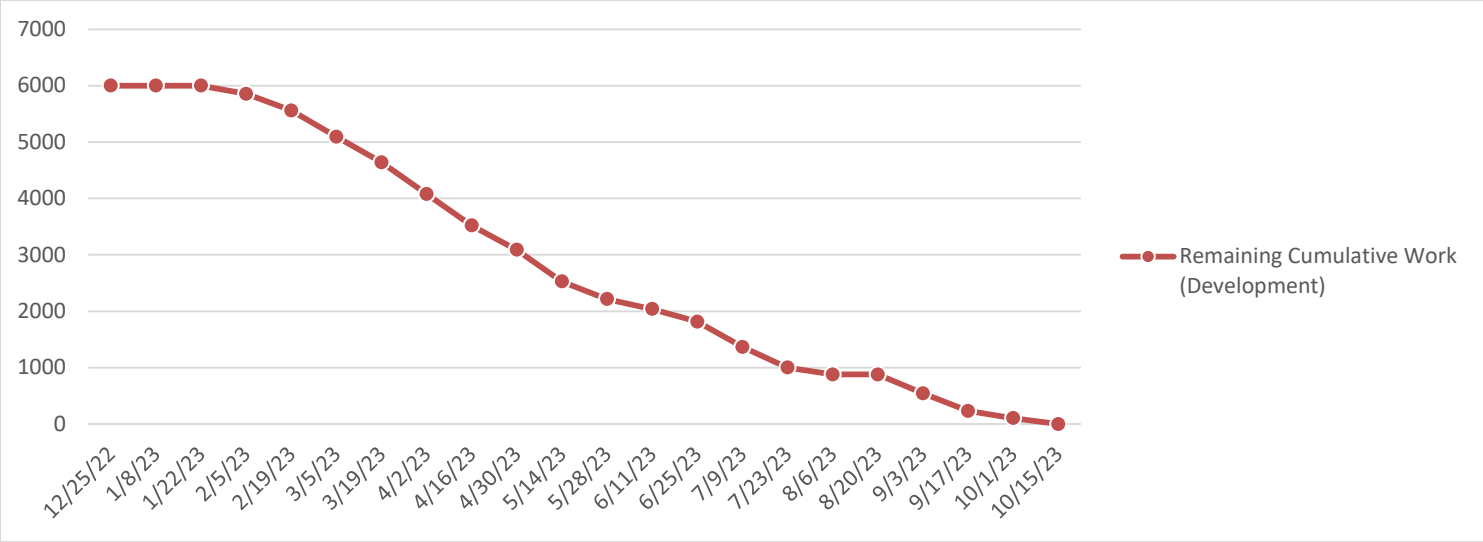
c. What is the total cost of the project?

The new total cost is $1,205,520.

d. Include a graph of the total financial schedule over the life of the project by month. This is the planned value for the project. The graph should depict time on the x-axis and dollars on the y-axis over the life of the project.



e. Include a graph of the Developer resource utilization over the life of the project by month. The graph should depict time on the x-axis and Developer utilization on the y-axis over the life of the project.



f. Include a screenshot of the total costs for each activity/work package.

	CCCC	300 days	Sun 1/1/23	Fri 10/27/23			0 days	$1,205,520.00
	System architecture	40 days	Sun 1/1/23	Thu 2/9/23		Design	0 days	$56,000.00
	Hardware specifications	50 days	Fri 2/10/23	Fri 3/31/23	2	Development,Design	17 days	$116,000.00
	Kernel specifications	20 days	Fri 2/10/23	Wed 3/1/23	2	Design	7 days	$28,000.00
	Utilities Specification	25 days	Fri 2/10/23	Mon 3/6/23	2	Development,Design	0 days	$58,000.00
	Hardware Design	35 days	Sat 4/1/23	Fri 5/5/23	3	Development[200%],Design[200%]	17 days	$162,400.00
	Disk drivers	85 days	Thu 3/2/23	Thu 5/25/23	4	Assembly/Test,Development[200%]	7 days	$139,400.00
	Memory management	75 days	Thu 3/2/23	Mon 5/15/23	4	Development	17 days	$69,000.00
	Operating system documentation	15 days	Thu 3/2/23	Thu 3/16/23	4	Design,Documentation	77 days	$30,000.00
	Routine utilities	18.33 days	Sun 5/14/23	Thu 6/1/23	5	Development[300%]	0 days	$50,600.00
	Complex utilities	42.5 days	Tue 4/18/23	Tue 5/30/23	5	Development[200%]	2 days	$78,200.00
	Utilities documentation	10 days	Fri 3/17/23	Sun 3/26/23	5	Documentation,Design	67 days	$20,000.00
	Hardware documentation	10 days	Sat 5/6/23	Mon 5/15/23	6	Documentation,Design	17 days	$20,000.00
	Integration first phase	30 days	Fri 6/2/23	Sat 7/1/23	7,8,9,10,11,12,13	Assembly/Test,Development[200%]	0 days	$60,200.00
	Prototypes	48 days	Sun 7/2/23	Fri 8/18/23	14	Assembly/Test,Development[200%]	0 days	$89,520.00
	Serial I/O drivers	42.5 days	Sun 7/2/23	Sun 8/13/23	14	Development[200%]	5.5 days	$78,200.00
	System hard/software test	15 days	Sat 8/19/23	Sat 9/2/23	15,16	Assembly/Test	0 days	$7,800.00
	Order printed circuit boards	5 days	Sun 9/3/23	Thu 9/7/23	17	Purchasing	0 days	$2,200.00
	Network interface	20 days	Sun 9/3/23	Fri 9/22/23	17	Development	15 days	$18,400.00
	Shell	20 days	Sun 9/3/23	Fri 9/22/23	17	Development	15 days	$18,400.00
	Project documentation	30 days	Sun 9/3/23	Mon 10/2/23	17	Documentation,Development	5 days	$45,600.00
	Assemble preproduction	20 days	Mon 9/18/23	Sat 10/7/23	18FS+10 days	Assembly/Test,Development	0 days	$28,800.00
	Integrated acceptance test	20 days	Sun 10/8/23	Fri 10/27/23	19,20,21,22	Assembly/Test,Development	0 days	$28,800.00

Remember, your financial schedule should follow your resource schedule, not the original network. Because the project has not started yet, all of your variances, schedule, cost, earned value, and actual cost should be zero. Once you are confident that you have the final schedule, save the file as a baseline. (Hint: Save a backup file just in case without baseline!)

Question 2

Prepare a status report using the information provided below. This requires saving your resource schedule as a baseline and inserting the appropriate status report date in MS Project. The MS Project tutorial on eLearning and the discussion forum pertaining to Earned Value Management may be of use in answering this question.

Activities Accomplished as of the end of the day March 1, 2023

Activity	Description	Actual Duration	Remaining Duration
1	System Architecture	40	0
2	Hardware specifications	20	35
3	Kernel specifications	20	20
4	Utilities Specification	20	30

a. Include a screenshot of the status report for the first quarter in table form that shows the Planned Value (PV), Earned Value (EV), Actual Cost (AC), Budget at Completion (BAC), Estimated Budget at Completion (ECAC), Estimated Time at Completion (ETAC), Schedule Variance (SV), and Cost Variance (CV) for (1) each work package and (2) the whole project.

ID	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC	VAC	Duration	Duration Variance
1	CCCC	$176,800.00	$135,381.47	$176,800.00	($41,418.53)	($41,418.53)	$1,574,336.14	$1,205,520.00	($368,816.14)	320.67 days	20.67 days
2	System architecture	$56,000.00	$56,000.00	$56,000.00	$0.00	$0.00	$56,000.00	$56,000.00	$0.00	40 days	0 days
3	Hardware specifications	$46,400.00	$42,181.47	$46,400.00	($4,218.53)	($4,218.53)	$127,601.06	$116,000.00	($11,601.06)	55 days	5 days
4	Kernel specifications	$28,000.00	$14,000.00	$28,000.00	($14,000.00)	($14,000.00)	$56,000.00	$28,000.00	($28,000.00)	40 days	20 days
5	Utilities Specification	$46,400.00	$23,200.00	$46,400.00	($23,200.00)	($23,200.00)	$116,000.00	$58,000.00	($58,000.00)	50 days	25 days
6	Hardware Design	$0.00	$0.00	$0.00	$0.00	$0.00	$162,400.00	$162,400.00	$0.00	35 days	0 days
7	Disk drivers	$0.00	$0.00	$0.00	$0.00	$0.00	$139,400.00	$139,400.00	$0.00	85 days	0 days
8	Memory management	$0.00	$0.00	$0.00	$0.00	$0.00	$69,000.00	$69,000.00	$0.00	75 days	0 days
9	Operating system documentation	$0.00	$0.00	$0.00	$0.00	$0.00	$30,000.00	$30,000.00	$0.00	15 days	0 days
10	Routine utilities	$0.00	$0.00	$0.00	$0.00	$0.00	$50,600.00	$50,600.00	$0.00	18.33 days	0 days
11	Complex utilities	$0.00	$0.00	$0.00	$0.00	$0.00	$78,200.00	$78,200.00	$0.00	42.5 days	0 days
12	Utilities documentation	$0.00	$0.00	$0.00	$0.00	$0.00	$20,000.00	$20,000.00	$0.00	10 days	0 days
13	Hardware documentation	$0.00	$0.00	$0.00	$0.00	$0.00	$20,000.00	$20,000.00	$0.00	10 days	0 days
14	Integration first phase	$0.00	$0.00	$0.00	$0.00	$0.00	$60,200.00	$60,200.00	$0.00	30 days	0 days
15	Prototypes	$0.00	$0.00	$0.00	$0.00	$0.00	$89,520.00	$89,520.00	$0.00	48 days	0 days
16	Serial I/O drivers	$0.00	$0.00	$0.00	$0.00	$0.00	$78,200.00	$78,200.00	$0.00	42.5 days	0 days
17	System hard/software test	$0.00	$0.00	$0.00	$0.00	$0.00	$7,800.00	$7,800.00	$0.00	15 days	0 days
18	Order printed circuit boards	$0.00	$0.00	$0.00	$0.00	$0.00	$2,200.00	$2,200.00	$0.00	5 days	0 days
19	Network interface	$0.00	$0.00	$0.00	$0.00	$0.00	$18,400.00	$18,400.00	$0.00	20 days	0 days
20	Shell	$0.00	$0.00	$0.00	$0.00	$0.00	$18,400.00	$18,400.00	$0.00	20 days	0 days
21	Project documentation	$0.00	$0.00	$0.00	$0.00	$0.00	$45,600.00	$45,600.00	$0.00	30 days	0 days
22	Assemble preproduction	$0.00	$0.00	$0.00	$0.00	$0.00	$28,800.00	$28,800.00	$0.00	20 days	0 days
23	Integrated acceptance test	$0.00	$0.00	$0.00	$0.00	$0.00	$28,800.00	$28,800.00	$0.00	20 days	0 days

b. Based on the performance of the project team in the first quarter, what are the Estimated Cost at Completion (ECAC) and the Estimated Time at Completion (ETAC) for the project as a whole?

The Estimated Cost at Completion (ECAC) of the project is $1,574,336.14 and the Estimated Time at Completion (ETAC) is 320.67 days. The total duration of the project as of the report date is recorded to be 320.67 days, which is ETAC.

c. How is the project as a whole progressing in terms of cost and schedule? Be specific in your response and clearly identify the amount, if any, the project is over/under budget and the schedule change, if any, the project is ahead/behind schedule in number of days.

Project Name	Schedule Performance	Cost Performance	TCPI
CCCC	0.77	0.77	1.04

The Schedule Performance Index (SPI), Cost Performance Index (CPI) is 0.77, and the To Complete Performance Index (TCPI) is 1.04.

- **The schedule performance is behind schedule because the earned value is below the planned value as of report date 03/01/2023.**
  - **The difference between the baseline project duration of 300 days and total duration of the current project performance of 320.67 days, which indicates that the project schedule will be behind by 20.67 days.**
- **The cost performance indicates that the project is estimated to be over budget because the earned value is smaller than the actual cost of the project as of report date 03/01/2023.**
  - **The difference between the baseline project cost (BAC) $1,205,520 and the estimated at cost (EAC) $1,574,336.14 indicates that the project is estimated to be over budget by $368,816.14 (Variance at Completion).**
- **When TCPI is greater than 1, in a normal case for BAS calculations, the value of the remaining project work must be executed at a better cost performance than the project's completed work.**
- **Earned Value (EV): $135,381.47, Planned Value (PV): $176,800; Actual Cost (AC): $176,800; Baseline BAC): $1,205,520**
- **Schedule Performance Index (SPI) = $135,381.47/$176,800 = 0.77; Cost Performance Index (CPI) = $135,381.47/$176,800 = 0.77**
- **To Complete Performance Index (TCPI) = ($1,205,520/$135,381.47) – ($1,205,520/$176,800) = 1.04**

d. Complete the following table describing the performance of each task in the project so far. For each task, compare the original planned schedule and cost with the actual schedule and cost as of March 1. For tasks that are in progress, please also include the estimated scheduled finish data and the estimated cost at completion and compare these estimates with the original plan.

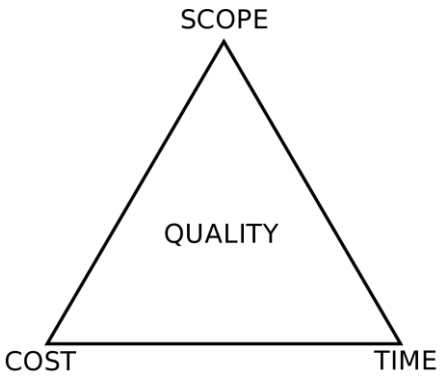
Activity	Description	Schedule Performance	Cost Performance
1	Architectural Decisions	1	1
2	Hardware specifications	0.91	0.91
3	Kernel specifications	0.5	0.5
4	Utilities Specification	0.5	0.5

	Original Planned Duration	Actual Completed Duration as of 03/01/2023	Duration Variance (original – ETAC)	Estimated Completed Duration (ETAC)	Original Planned Cost	Actual Completed Cost as of 03/01/2023	Variance at Completion (VAC)	Estimated Cost at Completion (ECAC)
Activity 1	40 days	40 days	0 days	40 days	$56,000	$56,000	$0	$56,000
Activity 2	50 days	20 days	Delayed 5 days	55 days	$116,000	$46,400	($11,601.06)	$127,601.06
Activity 3	20 days	20 days	Delayed 20 days	40 days	$28,000	$28,000	($28,000)	$56,000
Activity 4	25 days	20 days	Delayed 25 days	50 days	$58,000	$46,4000	($58,000)	$116,000

1. Architectural Decisions activity is on track with the original planned duration and cost
2. Hardware specifications activity is behind schedule by 5 days and over budget by $ 11,601.06.Planned completion date was 3/31/2023 and estimated completion date is 4/5/2023
3. Kernel specifications activity is behind schedule by 20 days and over budget by $ 28,000. Planned completion date was 3/1/2023 and estimated completion date is 3/21/2023
4. Utilities specifications activity is behind schedule by 25 days and over budget by $ 58,000. Planned completion date was 3/6/2023 and estimated completion date is 3/31/2023

e. What do you recommend doing to bring the project back on track? Be specific in your response indicating what changes, if any, you will make to complete the project at or ahead of schedule and at or under budget.

We are facing the classic challenge – the project management triangle which is made up of three variables that determine the quality of the project.



Three main interdependent constraints for every project; time, cost and scope

Steps: On schedule, over baseline cost.

After making changes to task as in question 2(a), budget and schedule has increased greatly compared to baseline. Bringing **both** cost and schedule back on track is not likely possible without changing project scope. A rushed job might look finished on paper, but **Quality of the project** will be compromised.

1. **Compressing schedule of the project at or ahead of schedule is possible by identifying the tasks that are not dependent on each other and can be completed in parallel.**
2. **Reallocating resources-> at this point since we are already over budget, adding more resources would increase cost. If we keep aside cost constraint and consider only schedule, then increasing resource allocation for tasks that are on critical path will compress overall project duration.**

The following 3 changes will compress duration from 320.65 days to 299.67 days:

a. For the task **Assembly Preproduction,** increased resource units from 100% to 200% for **Development and added 80hr overtime for Assembly/Test.**
b. For the task **Integrated acceptance test,** increased resource units from 100% to 200% for **Development and added 120hr overtime for Assembly/Test.**
c. For the task **System Hardware, added 48hr overtime for Assembly/Test.**

Note:

- **We started with project duration of 365days and budget $1,197,200**
- **After compressing project duration from 365days to 300days, baseline cost/budget was $ 1,205,520**
- **After making changes as per Question 2(a), budget got increased to $ 1,303,120 and duration of the project to 320.65 days**
- **After making changes to bring back schedule from 320.65 days to 300 days or less(back on track) as per question 2(e), budget is $1,311,180**

From these, the observation is, Schedule and Cost are inversely proportional. There is no easy way to bring back both schedule and cost back on track at the same time. However, the Agile Philosophy is one potential approach that can solve this constraint. Agile recognizes the cost, schedule, and scope constraints and says that scope is therefore a variable.

1. **This constraint is then managed by always trying to do the most important work first i.e., the parts that add most value.**
2. **In Agile, it is possible to swap resources between the tasks if there is a delay in a task and it is under -performing or is a lack of skill set.**
3. **In Agile, it's possible that we get to the end of the project without implementing all the tasks, but the most important tasks WILL have been implemented. Since we have implemented them early, they are well tested.**
4. **By the later part of the project, we might find that minor tasks that were originally on the plan are no longer required, or at least the product is useable with these minor activities missing.**
5. **In summary, by applying the Agile Philosophy to the project, which includes that making changes to the scope, we would be able to get the project back on schedule and on budget.**

Resource: project management triangle

Over schedule, meeting baseline cost.

1. **Unsuccessful at bringing the project back on budget due to the increase in duration for tasks 2,3, and 4. The duration increase for these tasks added a tremendous amount of cost to the overall project. Due to the constraints of only adding internal and external resources and overtime, there is not a lot of flexibility to make the necessary adjustments to bring the project back to its baseline cost without changing the scope of the project.**

f. Update your MS Project file to incorporate the changes listed in part 2e. Paste a copy of the revised Gantt chart below.