ME 4273 Systems Modeling and Analysis/ME 5213 Topics in Systems Modeling

Spring 2025, Final Exam

A part arrives every 10 minutes to a system having three workstations (A, B, and C), where each workstation has a single machine; the first part arrives at time 0. There are four-part types, each with equal probability of arriving (25%). The process plans for the four-part types are given below. The entries for the process times are the parameters for a triangular distribution (in minutes).

Part Type	Workstation/ Process Time	Workstation/ Process Time	Workstation/ Process Time
Part 1	A 5.5,9.5,13.5	C 8.5,14.1,19.7	
Part 2	A 8.9,13.5,18.1	B 9,15,21	C 4.3,8.5,12.7
Part 3	A 8.4,12,15.6	B 5.3,9.5,13.7	
Part 4	B 9.3,12.6,16.0	C 8.6,11.4,14.2	

Assume that the transfer time between arrival and the first station, between all stations, and between the last station and the system exit is 3 minutes.

Your Tasks:

A) (60 points) Build a simulation model that represents this system considering the following:

- Use the Sequence feature to direct the parts through the system and to assign the processing times at each station.
- Use the Sets feature to collect cycle times (total times in system) for each of the part types separately.
- Animate your model (including the part transfers)
- Run the simulation for a single replication of length 124,800 minutes (1 year), and collect statistics on the *average part cycle time* and the total number of parts of each type produced during the replication (report this in a text box in your Arena model file).

B) (40 points) Assume that all parts made at this facility are sold immediately with the following profits:

Part Type	Profit
Part 1	$20
Part 2	$18
Part 3	$15
Part 4	$29

The owners have the following upgrade options for the machines at the workstations. These upgrades will make the machines faster (same machines, not adding new ones). The following table shows the cost and increase in speed for each workstation.

Workstation	Upgrade Cost	New time vs old time
A	$150,000	0.9
B	$240,000	0.88
C	$130,000	0.93

The owners have budgeted at most $300,000 for upgrades this year. They need your help determining the best use of this budget. Keep in mind that declining to upgrade any of the machines is also an option.

- Define the net benefit in your output:

$$Net\ benefit = Profit\ per\ part \times Number\ of\ parts + Initial\ budget - Upgrade\ cost$$

- Define appropriate variables that indicate whether an upgrade is performed or not, and consequently the change in processing times, number of parts produced, and net benefit.
- Use one of the output analysis tools to show which scenarios result in statistically significant higher net benefit.