Tutorial 1: Practice Questions – MSBA7004

Tutorials for 7004 are optional. We will give you time to work on the practice questions during the tutorial, so you don't need to finish them before class. All the solutions and materials will be uploaded to moodle after class.

Part1: True or False questions

(Some of the statements shown below maybe incorrect, you should find out whether is true or false)

[ ] Flow units in a process could be homogeneous or heterogeneous.
[ ] If a process has two bottleneck resources, then they must have the same capacity rate.
[ ] In any process the non-bottleneck resource always gets idled for some time.
[ ] Buffers could have values added.
[ ] In any process, the flow time cannot be smaller than the cycle time.
[ ] The total duration of the process is the time spent on the bottleneck resource.
[ ] Increasing the capacity of the non-bottleneck resources does not increase the capacity rate of the process.

Part2: Practice questions

1. **[Quotable Manufactures]**

Quotable manufactures a removable disk for PC's. There are four major stages in its manufacture. The first stage is coating of disks. Coating is done by an automated machine that can run 24 hours/day. It produces 100 disks/hour. The second stage is assembly of the disk into the case. Assembly takes the average worker 2 minutes/disk. There are 10 workers at this stage. The third stage is testing, which catches defects from the coating operation. Each testing machine takes 5 minutes to test a disk. There are 30 machines and enough operators to keep these machines busy if necessary. The fourth stage is labeling the disk. Each worker here can do 2 disks/minute. There are 3 workers who do this task.

Assume the workforce completes 8 full hours of work each day, and stages 2 through 4 run 8 hours/day. Demand is 2100 disks/day.

Assume all rates and times are deterministic (no variability in demand or production). Testing finds no defects.

(a) Draw a simple process diagram

(b) Fill in the table below

Stage	Resource	Time (Tp) (minutes/disk)	Rate for one resource (1/Tp) (disks/hour)	Number of resources	Rate for all resources at this stage (disks/day)
1	Coating machine				
2	Assembly workers				
3	Testing machines and operators				
4	Labeling people				

(c) Explain why there is sufficient capacity to meet the demand.

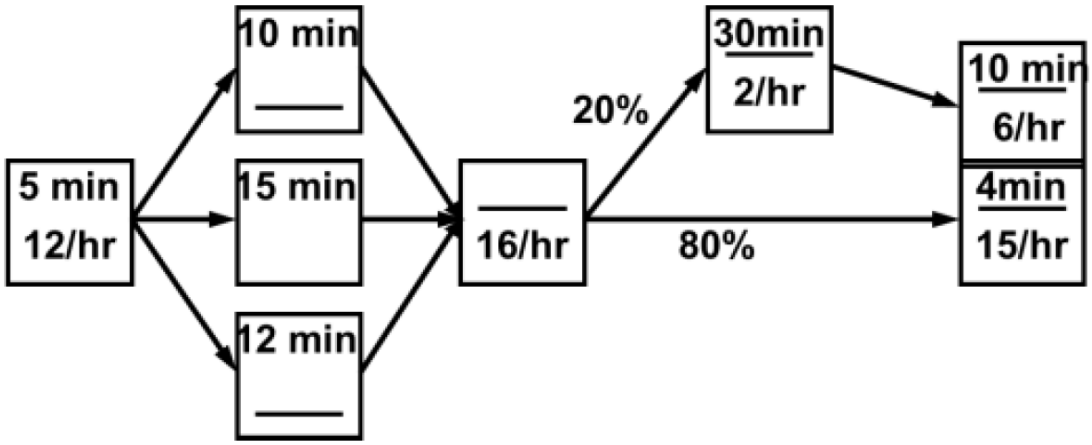
(d) If assembly and labeling are combined into a single step, can the process handle the demand? The raw processing time for one disk when assembly and labeling are combined into a single step equals to the sum of the original times. That is 2.5 minutes for one disk. Assume testing is done after this new combined step.

(e) How many people do we need in the combined stage in order to satisfy the demand?

2. **[Bottlenecks]**

For this problem assume all times and rates are deterministic and there is a reasonable amount of buffer between stages.

- Stage 1 has a single resource.
- Stage 2 has 3 servers. The job needs to visit only one of them, so these three work in parallel. The times the individual resources require are given.
- Stage 3 has a single resource
- Stage 4 is only required of 20% of the units.
- Stage 5 is a single resource that handles both the 20% of the units that go through stage 4 at the rate of 6/hr and the 80% of the units that don't use stage 4 at a rate of 15/hour.



Capacity rate: S_1 _____ S_2_____ S_3 _____ S_4 _____ S_5 _____

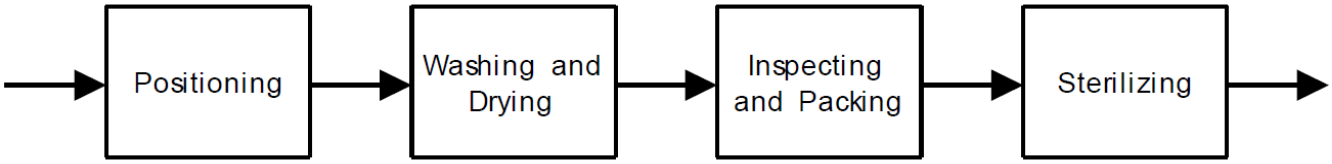
(a) Compute the capacity of each stage. (To better understand the question, imagine that the input consists of a pattern where one flow unit requiring "stage4" is followed by four flow units that do not require "stage4", and this pattern repeats.)

(b) Which stage is the bottleneck?

(c) Please calculate the maximum production rate of the system.

3. **[Capacity for Cleaning and Sterilizing in a Surgical Suite]**

Surgical instruments, when they are not in use, are stored in "trays" that are wrapped and kept sterile until they are needed. Once a tray of instruments has been used in surgery and returned to the supplies area the instruments must be 1) positioned for washing, 2) washed and dried, 3) inspected for damage and packed back in the tray, and 4) sterilized. The four-step process is shown below



Positioning is done by three people and a person can do one tray in 8 minutes.

The washing and drying is done by 10 automated machines. Each machine washes and dries a tray of instruments in 60 minutes. No labor is required except to place the instruments in the machine and take them out, which we will ignore for this problem.

Inspecting and packing can be broken into two cases. Everything is fine (80% of the trays) and some instrument is damaged (20% of the trays). When everything is fine it takes 9 minutes for one person to do. If any instrument is damaged, the average time to (1) repair or find a replacement and (2) inspect and pack is 22 minutes. Two people work at this stage, and both people do both steps.

The sterilizing step is like a baking or kiln operation that cannot be interrupted to add more trays. The sterilizing step takes 2.5 hours and the one "oven" can handle up to 24 trays at once.

(a) Use the table below and compute the capacity of each resource pool.

Resource Pool	Calculation step	Capacity of Resource pool (tray/hour)
Positioning people		
Washing and Drying machines		
Inspecting and Packing people		
Sterilizing "oven"		

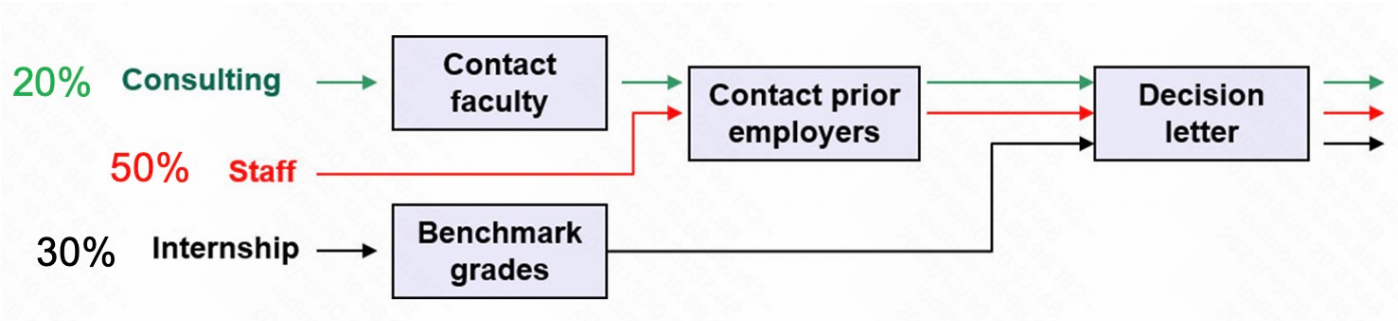
(b) What is the capacity of this system?

(c) An expansion of the OR will require that trays be handled at the rate of 12/hour. What changes / additions need to be made to meet this demand?

Part3: Optional practice questions

Process Analysis with Different Types of Flow Units

Assume the flow chart below shows the workflow of a Human Resource department. Three types of job applications need to be processed: “consulting,” “staff,” and “internship.” There are reasonable amount of inventory buffers in front of each resource/task (not shown).Each type of application has its own path through the process and does not necessarily visit all tasks. 20% of the arrived applications are consulting application, 50% are staff and 30% are internship. Unit load and numbers of workers for each task are given below:



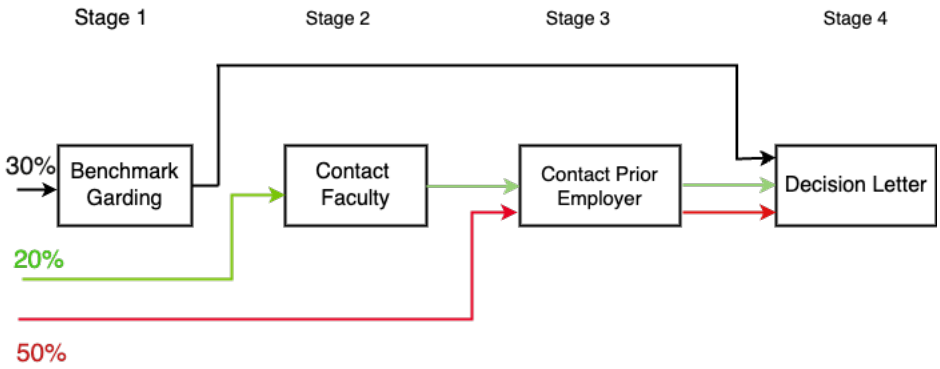
	Contact faculty	Contact employers	Benchmark grades	Decision letter
Unit load(min/app)	20	15	8	2
Number of workers	2	3	3	1

Which task is the bottleneck?

Can this process handle an arrival rate of 20 applications per hour?

What is the capacity rate of this process?

Method 1: Compute stage capacity



Capacity rate for Stage 1:

Capacity rate for Stage 2:

Capacity rate for Stage 3:

Capacity rate for Stage 4:

Method 2: Compute implied utilization

	Proportion	**Arrival Rate**
Consulting	20%	
Staff	50%	
Internship	30%	

	Contact faculty	Contact employers	Benchmark grades	Decision letter
Unit load(min/app)	20	15	8	2
Number of workers	2	3	3	1
Capacity rate (app/hour)				
Arrival rate (app/hour)				
Implied utilization				