Question 1

A production line is used to produce a product. Number of products at the start of the line is 200 units per week. The line consists of four stations. It is arranged such that an inspection station (I) is placed after three process stations (S1, S2, S3). The processing time of stations (S1, S2, S4, I) are (8, 10, 13, 8) minute respectively. Inspection station (I) has defect rate of 10%. 2% of the defects are scraped and the reminders are returned to station (S2). **Find**

(a) Determine the effective arrival rate at each station.
(b) Determine the number of machines at each station.
(c) Find the average work in process.
(d) Find the throughput time.

Question 2

A production line is used to produce a product. Number of products at the start of the line is 400 units per week. The line consists of four stations. It is arranged such that an inspection station (I) is placed after three process stations (S1, S2, S3). The processing time of stations (S1, S2, S4, I) are (8, 10, 13, 8) minute respectively. Inspection station (I) has defect rate of 10%. 4% of the defects are scraped and the reminders are returned to station (S2). **Find**

(a) Determine the effective arrival rate at each station.
(b) Determine the number of machines at each station.
(c) Find the average work in process.
(d) Find the throughput time.

Question 3

A production line is used to produce 25 units per week of a product. The product is assembled from one piece of part (a) and two pieces of part (b). The part (a) is produced through stations (A); station (B); and inspection station (C) with defect of 3% and reworked on station (B), while the part (b) is produced at station (D). After that, the two parts are assembled on station (E). The processing time of stations (A, B, C, D, E) are (40, 35, 10, 55, 15) minutes respectively. Then the product is tested on Inspection station (I) with processing time of 10 minutes and has defect rate of 6%. 50% of the defects are scraped and the reminders are returned to station (E).

A) Find
  (a) Determine the effective arrival rate at each station.
  (b) Determine the number of machines at each station.
  (c) Find the average work in process.
  (d) Find the throughput time.
B) Explain briefly a simulation model for the system

Question 4

A production line is used to produce 40 units per week of a product. The product is assembled from two pieces of part (a) and one piece of part (b). The part (a) is produced by at station (A) while the part (b) is produced at station (B). After that, the two parts are assembled on station (C). The processing time of stations (A, B, C) are (40, 48, 15) minutes respectively. The product is tested on Inspection station (I) with processing time of 10 minutes and has defect rate of 10%. 50% of the defects are scraped and the reminders are returned to station (D).

A) Find
  (a) Determine the effective arrival rate at each station.
  (b) Determine the number of machines at each station.
  (c) Find the average work in process.
  (d) Find the throughput time.
B) Explain briefly the simulation model for the system

Question 5

An assembly line produces two models (A, B) in a ratio of (2:3) respectively. The line consists of seven stations. It is arranged such that an inspection station (I) is placed after two assembly stations (S1, S2) and hence it is branched to produce each model. Model (A) is produced by assembly station (SA) followed by inspection station (IA). Also, Model (B) is produced by assembly station (SB) followed by inspection station (IB). **Find** the expected number of model A and B, and the throughput given the following data:

- Number of products at the start of the line is 440 units per week.
- Inspection station (I) has scrap rate of 8%.
- Inspection station (IA) has failure rate of 5%, which return to assembly station (SA).
- Inspection station (IB) has failure rate of 7%, which return to assembly station (SB).
- Processing Time of stations (S1, S2, I, SA, IA, SB, IB) are (5, 4, 3, 4, 3, 5, 3) min. respectively.

Question 6

Three parts are processed using three machining centers (C1, C2, and C3) as indicated in Table (1). **Determine:**

(a) The effective arrival rate at each center.
(b) The average processing time at each center.
(c) The average number of parts in process.
(d) The throughput time for each part.

TABLE (1)

Product	Demand / Week	Routing Data [Centers, Process Time in hr]		
		1	2	3
P1	9	C1, 2	C2, 1	C3, 1
P2	10	C2, 1.2	C3, 1.5	-
P3	8	C2, 1.2	C1, 1.5	C3, 1.2

Question 7

Four parts are processed using three machining centers as indicated in Table (5). The centers C1, C2, C3 consist of 3, 2, 3 machines respectively.

Determine:

(a) the effective arrival rate at each center.
(b) the average processing time at each center.
(c) the average number of jobs in process.
(d) the throughput time for each parts.

Table (5)

Product	Demand /Week	Routing Data [Centers, Process Time, min]		
		1	2	3
1	25	C1, 40	C3, 70	C2, 50
2	15	C2, 80	C3, 90	-
3	10	C1, 90	C2, 100	C3, 80
4	15	C1, 40	C2, 80	-

Question 8

Five parts are processed using four machining centers as indicated in Table (1). The centers C1, C2, C3, C4 consist of 2, 1, 2, 1 machines respectively.

(a) Determine the effective arrival rate at each center.
(b) Determine the average processing time at each center.
(c) Find the average number of jobs in process.
(d) Find the throughput time for each parts.

Table (1)

Product	Demand/ Week	Routing Data [Centers, Process Time in hr]			
		1	2	3	4
1	15	C3, 1	C2, 2	C1, 1	C4, 2
2	10	C4, 3	C1, 3	C2, 2	C3, 1
3	6	C4, 4	C3, 2	C1, 2	-
4	10	C3, 2	C4, 3	C2, 2	C1, 1
5	8	C3, 3	C2, 1	C1, 2	-

Question 9

Five parts are processed using four machining centers (C1, C2, C3, C4) as indicated in Table (1).

(a) Determine the effective arrival rate at each center.
(b) Determine the average processing time at each center.
(c) Determine number of machines in each center
(d) Find the average number of jobs in process.
(e) Find the throughput time for each parts.

Question 10

Five parts are processed using four machining centers as indicated in Table (2). The centers C1, C2, C3, C4 consist of 2, 1, 2, 1 machines respectively.

(a) Determine the effective arrival rate at each center.
(b) Determine the average processing time at each center.
(c) Find the average number of parts in process.
(d) Find the throughput time for each parts.
(e) Can each center produce all parts of the products? Why?

TABLE (2)

Product	Demand/ Week	Routing Data [Centers, Process Time in hr]			
		1	2	3	4
1	9	C3, 2	C2, 2	C4, 1	-
2	8	C4, 1	C1, 3	C2, 2	C3, 3
3	9	C3, 2	C1, 2	-	-
4	6	C3, 3	C2, 1	C4, 1	C1, 1
5	5	C2, 1	C4, 2	C1, 2	-

Question 11

Five parts are processed using four machining centers as indicated in Table (2). The centers C1, C2, C3, C4 consist of 2, 1, 2, 1 machines respectively.

(a) Determine the effective arrival rate at each center.
(b) Determine the average processing time at each center.
(c) Find the average number of jobs in process.
(d) Find the throughput time for each parts.

Table (2)

Product	Demand/ Week	Routing Data [Centers, Process Time in hr]			
		1	2	3	4
1	14	C3, 1	C2, 2	C4, 2	-
2	9	C4, 3	C1, 3	C2, 2	C3, 1
3	7	C3, 2	C1, 2	-	-
4	10	C3, 2	C4, 3	C2, 2	C1, 1
5	12	C3, 3	C2, 1	C1, 2	-

Question 12

A five department manufacturing system is used to produce five parts according the data given in table (2). **Find**

(a) Determine the effective arrival rate at each department.
(b) Determine the number of machines at each station.
(c) Find the average work in process.
(d) Find the throughput time.

TABLE (2)

Part	Weekly Demand	Process Sequence	Operation Time, hr					
			Load	Process Station				Unload
			A	B	C	D	E	A
1	240	A → C → B → D → A	0.2	2	1.5	2.1	0	0.2
2	280	A → B → D → E → A	0.2	2.8	0	2.2	1.5	0.2
3	120	A → C → D → A	0.2	0	1.5	1.8	2	0.2
4	200	A → E → B → A	0.2	1.5	0	0	2.2	0.2
5	160	A → B → E → C → A	0.2	2.5	2	0	1.8	0.2

Question 13

A factory consisting of five production deparments (A,B,C,D,E) and storage department (S) produces five products according the data given in table (1). Determine:-

i) the effective arrival rate at each department.
ii) the average processing time at each department.
iii) the number of machines in each department
iv) the number of forklifts required to handle the pallets between departments.
v) the average number of jobs in process.
vi) the throughput time for each parts.
vii) a simulation model for the maunufacturing system stating your objective

Table (1)

Part	Monthly Demand	Process routing (deparment, processing time, min)
1	240	S → (A,40) → (B,50) → (C,60)→ (D,30) → S
2	200	S → (B,35) → (C,40) → (D,40) → S
3	160	S → (A,65) → (D,35) → (E,40) → S
4	100	S → (B,55) → (E ,35)→ (D,40)→ S
5	140	S → (C,30) → (D,45) → (E,50) → S
Forklift between department take 15 min to move a pallet contains (5 parts)		

Question 14

A- Differentiate between open network and closed network manufacturing systems

B- Why the clalculation of the open network manufacturing system can be done on the bases of single station queue system?

C- What is meant by effective arrival rate?

D- Give the steps for calculating the throughput for closed network manufacturing system with N workstations and M products.

Queue length equation for single server

$$L = \frac{\rho}{1-\rho},\ \mathrm{L_q} = \frac{\lambda^2}{\mu(\mu-\lambda)},\ \rho = \frac{\lambda}{\mu},\ \mathrm{P_o} = 1-\rho$$

Throughput Time Equation

$$W = \frac{L}{\lambda},\ W_q = \frac{L_q}{\lambda}$$

Queue length equation for multi server

$$L = L_q + \frac{\lambda}{\mu},\ L_q = \frac{P_o(\lambda/\mu)^n \rho}{n!(1-\rho)^2},\ \rho = \frac{\lambda}{n\mu},\ P_o = \frac{1}{\sum_{i=0}^{i=n-1}(\lambda/\mu)^i + \frac{(\lambda/\mu)^n}{n!} \times \frac{1}{1-(\lambda/n\mu)}}$$

Question 1:

The manufacturing cell illustrated in Figure 1 is used to produce specific parts that are processed based on the following sequence: The operator place a pallet that has 24 parts in the position of buffer-1 then the robot picks the part and loads Machine-1 to perform the first operation. The robot also unloads Machine-1 and moves the part to Machine-2 to perform the second operation. Then, the robot unloads Machine-2 and places the part on another pallet (the capacity is 24) located in the position of buffer-2. After placing 24 of finished parts on the pallet located in buffer-2, the operator removes the filled pallet and places a new empty pallet. Also, if all parts (24 parts) are consumed from the pallet located in buffer-1, the operator replaces the empty pallet with a filled one. Design the system with Petri Net model. (Describe places, and transitions and the initial marking).

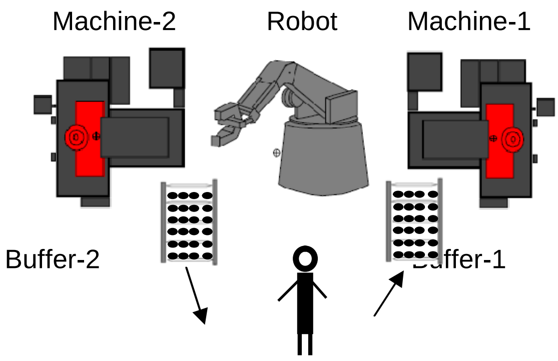


Figure 1.

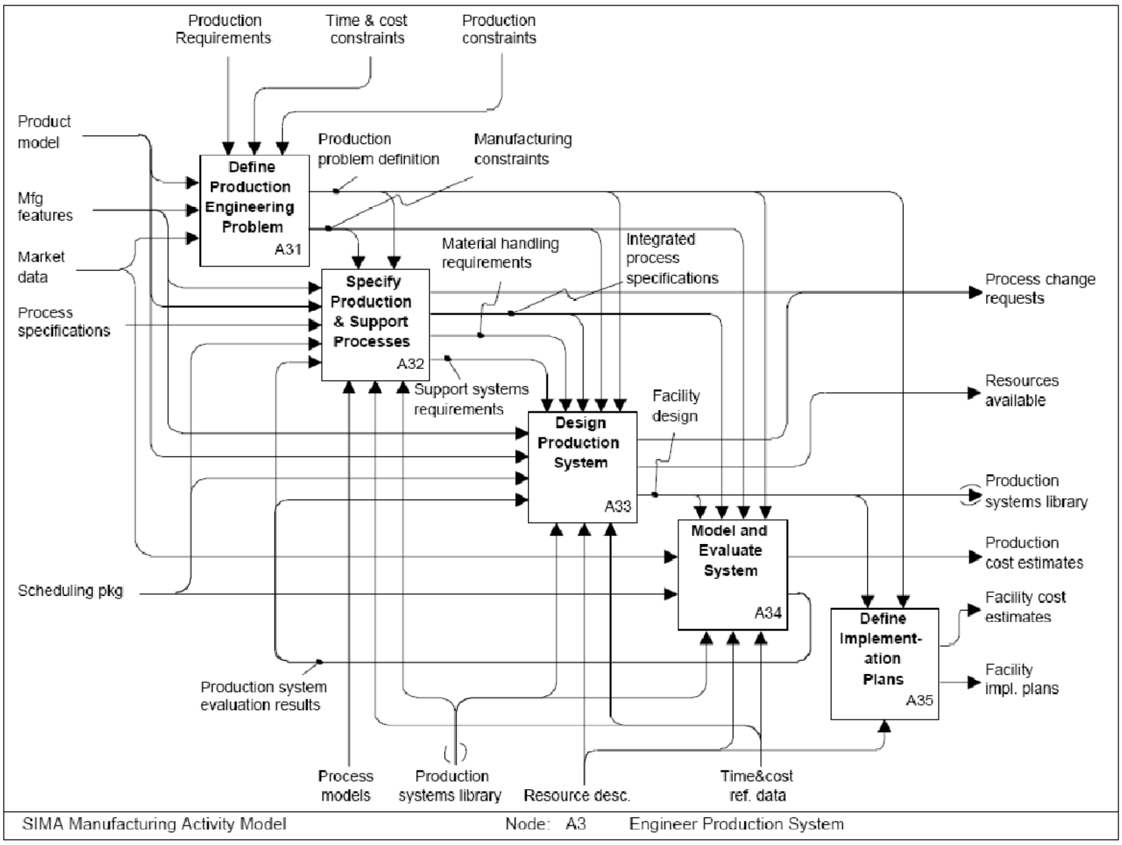
Question 2:

In small motors manufacturing company, rotor assembly activity involves five sub-activities (heating operation, assembling shaft/rotors, cooling the shaft/rotor sub-assembly, machining the shaft/rotor sub-assembly, and completing the scaling operation).There are four main inputs to rotor assembly activity: MRP orders, special orders, rotors, and shafts. The operations of rotor assembly are controlled by a daily schedule and design specifications. The different operations of this activity (rotor assembly) are performed by machines/tools and operators in order to obtain the two major outputs: rotor assembly information and finished rotor assemblies. Develop IDEF0 model for rotor assembly activity and its sub activities.

Question 3:

Consider the following diagram of an IDEF0 model and **Determine the following:**

1. the parent function of this diagram?
2. ICOMs of activity A35?
3. an examples for branching
4. an example for joining.
5. an example for feedback.
6. an example for bundling
7. an example for unbundling
8. two examples for the two types of tunneled arrows (define their concepts).


Production Requirements
Time & cost constraints
Production constraints
Product model
Mfg features
Market data
Process specifications
Scheduling pkg
Define Production Engineering Problem
A31
Production problem definition
Manufacturing constraints
Specify Production & Support Processes
A32
Material handling requirements
Integrated process specifications
Support systems requirements
Design Production System
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Facility design
Model and Evaluate System
A34
Define Implement-ation Plans
A35
Process change requests
Resources available
Production systems library
Production cost estimates
Facility cost estimates
Facility impl. plans
Production system evaluation results
Process models
Production systems library
Resource desc.
Time&cost ref. data
SIMA Manufacturing Activity Model
Node: A3
Engineer Production System