Question 1 (5%)
List three different models or algorithms supporting lean manufacturing?

– Clustering algorithms (GT models)
– Scheduling algorithms
– Resource Selection Model

Question 2 (5%)
What is the main difference between lean manufacturing and agile manufacturing?

– Lean manufacturing
  • Emphasis on cost reduction
– Agile manufacturing
  • Emphasis on overall manufacturing system flexibility (beyond the manufacturing floor)

Question 3 (5%)
What differentiates kanban from kaizen?

– Kanban
  • A card
  • Reduces inventory and production cycle time
  • Productivity improvement
– Kaizen
  • Continuous improvement
  • Problem domains can include all aspects of manufacturing and administration
  • Problem solving by teams

Question 4 (25%)
An assembly system is to process 100 circuits per hour. It takes 20 minutes to receive the necessary components from the preceding workstation. Completed circuits are placed on a rack that holds 10 boards. The rack must be full before it is sent to the next station. If the factory uses a safety factor of 5%, how many kanbans are needed for the circuit board assembly process?

The number of Kanbans = (Units daily demand × order cycle time × safety factor) / Lot size
Assuming 8 working hours per day,

Given: 100 circuits per hour
lot size of 10
20 minute cycle time/lot
Safety factor = 1.05

Number of Kanbans = 8*(100*(20/60))*1.05/10
= 28 Kanbans per 8 hours.

28 Kanbans per 8 hours are needed.
Question 5 (25%)
The matrix below represents an assembly system with five stations and seven assemblies. Decompose the system into two subsystems with a suitable clustering algorithm.

Assume: Stations \( \rightarrow \) Machine & Assemblies \( \rightarrow \) Part Numbers

\[
\begin{array}{ccccccc}
1 & 2 & 3 & 4 & 5 & 6 & 7 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 \\
2 & 1 & 1 & 1 & 1 & 1 & 1 \\
3 & 1 & 1 & 1 & 1 & 1 & 1 \\
4 & 1 & 1 & 1 & 1 & 1 & 1 \\
5 & 1 & 1 & 1 & 1 & 1 & 1 \\
\end{array}
\]

The Cluster Identification algorithm results in the following decomposition:

Two part families and machine cells:
- PF1: \{2,4,5,7\} and MC-1: \{1,4,5\}
- PF2: \{1,3,6\} and MC-2: \{2,3\}

Note that at the same time machine 2 has become bottleneck.

Question 6 (10%)
Introduce a bottleneck station and a bottleneck assembly (one at a time) to the clustered matrix generated in Question 5.

Solution: The organized part-machine matrix obtained in Question 5 is as follows:

\[
\begin{array}{ccccccc}
1 & 2 & 3 & 4 & 5 & 6 & 7 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 \\
2 & 1 & 1 & 1 & 1 & 1 & 1 \\
3 & 1 & 1 & 1 & 1 & 1 & 1 \\
4 & 1 & 1 & 1 & 1 & 1 & 1 \\
5 & 1 & 1 & 1 & 1 & 1 & 1 \\
\end{array}
\]

Adding to the parts processed in one cell operations to be processed in another cell creates a bottleneck machine, e.g., machine 5.

Note that by creating the bottleneck machine has been created by bottleneck parts.

Question 7 (25%)
Figure 1(a) shows a part with nine elementary features to be removed by a machining process. Plane P is a tolerance base for the following elementary machining features: e5, e6 and e9.
Question 7 (25%)

A. Which of the six tool paths in Figure 1(b) are not feasible?
B. Correct the matrix and justify your answer.

Answer:

Corrected matrix

B. Write down precedence constraints for the tool paths from Figure 1(b) that involve the elementary machining features: e5, e6, and e9.

Plane P is a tolerance base for e5, e6, and e9; V1 must be removed before we remove machining features that contain e5, e6, and e9.