



OMF 751 – LEAN SIX SIGMA(Common to CSE, IT, ECE & MECH)

UNIT I

Lean and Six Sigma Background and Fundamentals

PART - A

1. Define Lean.

Ans. : Lean addresses waste removal from organizational processes in order to improve efficiency.

2. What is Quality ?

Ans. : “Quality” in a manufacturing organization has so many meanings, there are Quality Management Systems, Quality Managers, statistical process controls and older one termed as Quality Circles. The focus in the manufacturing is now turning from Quality to Lean.

3. What is six sigma ?

Ans. :

- ☐ Six Sigma (**6σ**) is a set of techniques and tools for process improvement. It was introduced by American engineer **Bill Smith** while working at Motorola in **1986**. A six sigma process is one in which 99.99966 % of all opportunities to generate some feature of a part are statistically expected to be free of defects.
- ☐ Six Sigma strategies seek to improve the quality of the output of the process, by identifying and removing the causes of defects and also minimizing the impact variability in the manufacturing and business processes.

4. What is CODN ?

Ans. :

- ☐ **Cost Of Doing Nothing, “It takes money to make money”** In the world of Six Sigma quality, the saying also holds true : it takes money to save money using the Six Sigma quality methodology.
- ☐ When the leaders who assess Six sigma must consider certain other options like:
 - Doing nothing
 - Creating Six sigma strategy
 - Creating six sigma Initiatives within the organization.

5. What is COPQ ?

Ans. : Cost Of Quality (COQ) is defined as a methodology that allows an organization to determine the extent to which its resources are used for activities that prevent poor quality, that appraise the quality of the organization’s products or services, and that result from internal and external failures.

6. List out the three categories of COPQ.

Ans. :

- ☐ Appraisal costs : Costs incurred to determine the degree of conformance to quality requirements.
- ☐ Internal failure costs : Costs associated with defects found before the customer receives the product or service.
- External failure costs : Costs associated with defects found after the customer receives the product or service.

7. Define DMAIC.

Ans. : The tools of this methodology are applied within a simple performance improvement model known as Define-Measure-Analyze-Improve-Control, or DMAIC.

DMAIC is described briefly as follows :

- ☐ D - Define the goals of the improvement activity.
- ☐ M - Measure the existing system.
- ☐ A - Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal.
- ☐ I - Improve the system.
- ☐ C - Control the new system.

8. What is TQM ?

Ans. : Total Quality Management (TQM) is a management style that involves :

- Commitment from everyone in the organization.
- Dedication to a high level of quality in every process.
- A focus on customer satisfaction.

TQM has a significant focus on continual improvement. It integrates all functions within an organization.

9. What are the eight basic principles in Total Quality Management ?

Ans. : These principles work together to improve processes and end results for customer and business alike.

10. Define change management.

Ans. : Change management can help solidify a new culture in individuals and organizations. The four ways that change management can be used to instill Six Sigma culture into an organization,

- Create Awareness and Desire
- Expose the Organization to Change
- Move Ahead, and Be Prepared for Surprises
- Reward Generously
-

11. What are the advantages of lean ?

Ans. : Lean's main strength is its fast implementation, and almost immediately visible results.

Short term benefits include :

- A rise in productivity
- Error reduction
- Shorter customer lead times.
- With better planning and execution, Lean can improve financial performance, customer satisfaction, and staff morale.

12. What are the similarities between Six sigma and TQM ?

Ans. :

Six Sigma and TQM both methods are used to monitor quality of products, processes, and services.

TQM is an application of quantitative methods and human resources to improve all the processes within the organization.

Six Sigma is a problem solving approach and the main aim is defect reduction and variation management.

While both aim to decrease the number of defects and errors created.

13. *Mention the differences between lean manufacturing and six sigma.*

Ans. :

- Mainly, the difference is in the approach toward this goal, and each system's definition of the root cause of waste.
- While Lean is traditionally manufacturing-oriented, and is quicker to implement, Six Sigma is armed with the power of data for decision making, and is consumer-centric at its core.
- Six Sigma is a broader process that easily adapts to the application of manufacturing processes, but it also serves as a big picture approach to strategy in business by using statistical models.
- When applied to manufacturing, Six Sigma is an evaluation process used to identify weaknesses and improve the overall process.
- Lean manufacturing is similar, but it works in a very narrow scope that's focused heavily on waste and production. Use less, do more is the essential backbone of lean manufacturing methodology.

14. *Define Process Tolerance.*

Ans. : Process tolerance is a value that sets the standard by which the capability of your process is determined. It is defined as a multiple of a process standard deviation (sigma). Usually, 6*sigma is used as a tolerance. Some processes require a higher, stricter tolerance than others.

15. *What are the major implications of Quality level ?*

Ans. : The major Implications of quality levels are,

- In order to improve the entire process, Six Sigma does the required things better and faster, that too at a much lower cost.
- This can be employed in various facets of business, right from human resource to production and order entry to technical support with utmost ease and convenience.
- The best part of adopting Six Sigma approach is getting a clear focus on quality improvement methods that are extremely crucial to the valuable customers.
- It can wonderfully eliminate the process variation and also inconsistency.
- This is known to bring about active participation of top management.

Part – B & C

1. Discuss the importance of Lean manufacturing process.
2. Outline the relevance of six sigma and process tolerance.
3. Discuss how the lean and six sigma practices are used in an organization.
4. How will you assess the six sigma needs to increase productivity?
5. Discuss on TQM and Six sigma in detail.
6. Outline the six sigma and its cultural changes in the organization.
7. How a change management is implemented in the organization ?
8. Explain in detail about the implications of quality level.

UNIT II

The Scope of Tools and Techniques

PART - A

1. Expand and explain DMAIC.

Ans. :

- **Define** the problem. Craft a problem statement, goal statement, project charter, customer requirement, and process map.
- **Measure** the current process.
- **Analyze** the cause of issues.
- **Improve** the process.
- **Control**.

2. Define IPO diagram.

Ans. : A visual representation of a process or system where inputs are represented by input arrows to a box (representing the process or system) and outputs are shown using arrows emanating out of the box. The input data shows that will be used by the process.

The process itself is the steps used to solve problems that illustrate the working of the function. While output is a data item produced or modified by the steps in the process.

3. What is SIPOC ?

Ans. :

Supplier – The provider of inputs into a process

Input – Materials, information and other resources needed to complete a process

Process – Structured steps used to convert inputs into outputs

Outputs – Products or services resulting from the process

Customer – Recipient of the outputs.

4. List the components of CTQ tree.

Ans. :

Need – What customer need are you fulfilling with your product or service ?

Drivers – What elements or characteristics will your customers mostly likely consider when judging the quality of your product or service ?

Requirements – What process or product requirements are needed to make those drivers meet customer standards ?

5. What are the elements of project charter ?

Ans. :

- Business Case
- Problem / Opportunity Statement
- Goals / Projected Benefits
- Goal statement
- Project Scope
- Project Plan
- Team Structure

6. What are the characteristics of histogram ?

Ans. :

- Histogram is used to represent categorization of Continuous data • There is no gap between the bars unlike Bar graph, to signify that the data is continuous
- The width of the groups is equal.

7. Write the formula for width calculation of histogram.

Ans. :

Width = Total range of population / Number of categories

8. Define pareto principle.

Ans. : Often called the 80-20 rule, the Pareto Principle is a common 'rule of thumb' that "80 % of the effects of something can be attributed to 20% of the drivers."

9. What is process capability ?

Ans. : Process Capability (Cp) is a measure of the relationship between the voice of the process and the Voice of Customer (VOC). It is essentially a ratio of the customer requirement (specification) and the expected process variation.

Process capability = Voice of the customer / Voice of the process

10. List out the advantages of regression analysis.

Ans. :

- Decreased work-in-progress
- Improved process flow
- Increased productivity
- Improved inventory turns
- Reduced cycle time

11. What is positive, negative and zero correlation ?

Ans. : Correlation coefficient value of 1 indicates perfect **positive correlation** - as one variable increases, the second increases in a linear fashion. Likewise, a value of -1 indicates perfect **negative correlation** - as one variable increases, the second decreases. A value of zero indicates **zero correlation**.

12. What are the advantages of PESTLE tool ?

Ans. :

- The tool is simple and easy to understand and use.
- The tool helps understand the business environment better.
- The tool encourages the development of strategic thinking.
- The tool helps reduce the effect of future business threats.
- The tool enables projects to spot new opportunities and exploit them effectively.

13. What is OEE ?

Ans. : Overall Equipment Effectiveness. A standard machine performance measurement that encompasses all loss of time on a machine or process that is not contributing to good parts or outputs. It is equal to the combined effect of Availability □ Performance □ Quality.

14. What is the need for affinity diagram ?

Ans. : The affinity diagram will be used when

1. Group agreement for a discussing conclusion
2. A complicated issue with copious divisions
3. Plenty of disordered information and data
4. After analyzing verbal data

15. Define Gantt chart.

Ans. : A Gantt chart is a powerful and preferred visual reporting device used for conveying a project's schedule.

A typical Gantt chart graphically displays the work breakdown, total duration needed to complete tasks, as well as % completion.

PART B & C

1. Explain in detail about the tools for definition.
2. Explain about
 - i. Pareto Charts
 - ii. Control Charts
 - iii. Flow Process Charts
3. Explain about SWOT and PESTLE.
4. What is the need for improvement phase and explain about the tools of improvement.
5. Explain in detail about SMED with an example.
6. Explain about Gantt Chart and Radar Chart.
7. Explain about Project Charter.
8. Explain about cause and effect diagram with an example.

UNIT III

Six Sigma Methodologies

PART - A

1. What is DFSS ?

Ans. : Design for Six Sigma (DFSS) focuses on performing additional work up front to assure you fully understand the customer's needs and expectations prior to design completion. DFSS requires involvement by all stakeholders in every function. When following a DFSS methodology you can achieve higher levels of quality for new products or processes.

2. Expand DMADV.

Ans. : Define, Measure, Analyze, Design, Verify

3. List out the methods of DFSS.

Ans. : Various methods of DFSS are

- ☐ Finite Element Analysis (FEA)
- ☐ Failure Modes and Effects Analysis (FMEA)
- ☐ Tolerance Stack Analysis
- ☐ Design Of Experiment (DOE)

4. Define FMEA.

Ans. : Failure Mode Effect Analysis identifies all the probable failure modes for the product or process. It prioritizes the failure modes for focused attention by using a scoring model based on Severity (S), Occurrence (O) and Detect ability (D).

5. What is RPN ?

Ans. : Risk Priority Number (RPN) is a measure used when assessing risk to help identify critical failure modes associated with your design or process. The RPN values range from 1 (absolute best) to 1000 (absolute worst).

6. Define CAP.

Ans. : Change Acceleration Processes (CAP) represents a group of change management tools that are used to help the change effort to be accelerated towards a common goal.

A change management framework with a set of tools to gauge the political/strategic/cultural environment in the organization and plan for action which will eventually determine how much success a change initiative can bring in within the existing operating boundaries.

7. Explain ARMI.

Ans. :

- **A** - Approval of team decisions
- **R** - Resource of the team, one whose expertise/ skills may be needed
- **M** - Member of team, with the authorities and boundaries of the charter
- **I** - Interested Party, one who will need to keep informed on direction and findings

8. What is project acceptability?

Ans. : Project Acceptability is based on the below equation :

Effectiveness of a solution = Quality of a solution * Acceptability of the solution.

9. List out some of the communication tactics.

Ans. :

- Face-to-face meetings
- Town halls
- CEO memos to employees
- Presentations at staff/management meetings
- Videotapes of key meetings
- Sets of frequently asked questions and answers

10. Define stakeholders with an example.

Ans. : Stakeholders are people who will be affected by the project or can influence it but who are not directly involved with doing the project work.

Examples are Managers affected by the project, Process Owners, People who work with the process under study, internal departments that support the process, customers, suppliers, and financial department.

11. What are the categories of stakeholders ?

Ans. : The categories are

- Project team
- Project sponsor
- Functional Manager
- Top Management and
- Regulatory Bodies

12. What are the information specified in risk plan ?

- Risks associated with the project
- Impact of risks against the success of the project
- Outline / plan for managing any project risk

13. Expand the following FEA and DOE.

Ans. :

- FEA – Finite Element Analysis
- DOE – Design Of Experiment

14. Define Severity, Occurrence and Detection.

Ans. :

- ☐ Severity – Importance of an effect on critical quality parameter (1-Not severe; 10 – very severe)
- ☐ Occurrence – Frequency with which a cause occurs (1-Not likely; 10-Very likely)
- ☐ Detection – Ability of current control to detect the cause before creating a failure mode (1-likely to detect; 10-not likely to detect)

15. List out the steps of FMEA.

Ans. :

- Recognize and evaluate potential failure modes
- Use Risk Priorities Numbers to evaluate the modes.
- Identify the cause of failure
- Identify the actions which could prevent failures
- Document ideas of the team.

PART B & C

1. Explain in detail about DFSS.
2. Elaborate about the process of FMEA.
3. Explain about CAP in detail.
4. Explain with examples of severity, occurrence and detection rankings.
5. Define RPN and the calculation of the same with example.
6. Explain in detail about leadership in six sigma.
7. Explain about communication plan with an example.
8. Who are stakeholders and what are the roles of stakeholders in six sigma process ?

UNIT – IV

Six Sigma Implementation and Challenges

PART - A

1. List out the tools used for six sigma implementation.

Ans. : Tools used are,

- Affinity Diagram
- Relationship Diagram
- Tree Diagram
- Matrix Diagram
- Process Decision Program Chart (PDPC)
- Activity Network Diagram (AND)
- Supplier Input Process Output Customer (SIPOC)
- Quality Function Deployment or House of Quality (QFD)

2. What is SIPOC ?

Ans. : SIPOC is the acronym for SUPPLIER, or the source of input, INPUT or the materials needed for the process, PROCESS, OUTPUT, what is produced by the process and CUSTOMERS, the end users of the output. SIPOC is a high level management tool that simplifies the variables of any given process into five segments.

3. Define QFD.

Ans. : It means Quality Function Deployment or House of Quality. It is used to market products and services faster, cheaper, and better. In the earlier years, manufacturers used QFD to assure that the end product is produced according to design.

By using QFD, organizations are able to answer questions like :

- How do we know which consumer to ask ?
- How do we know the end user's specific product requirement?
- What features do we need to include?

4. Customer quality Index.

Ans. : Quality is a subjective term. Each type of 'customer' will have their own slant on 'quality' - the accounting department might define quality in terms of profits while an end-user might define quality as user-friendly and bug-free. Quality Index is a measure of quality. The objective of calculating QI is to achieve customer satisfaction and also result in improved productivity, reduced errors, reduced training and improved acceptance.

5. What are the needs of Quality Index ?

Ans. : The need for Quality Index is, Customer satisfaction is one of the most critical things when it comes to quality of the application. Based on the QI, one can measure customer satisfaction.

When the quality index is applied, it will be easy for the management to digest one number and drill down the other, if required.

The QI trend provides continuous feedback, which is required for control. It is easy to monitor when the process is going out-of-control.

6. What are the challenges considered in six sigma ?

Ans. : Challenges arise not with Six Sigma itself, but with how it is applied and the people who apply it. The two challenges that may take place in six sigma implementation are,

- ☐ Challenges with People
- ☐ Challenges with Implementation

7. Define program failure.

Ans. : There are any numbers of reasons why some projects fail, and organization experiences at least some extent. By understanding the chief points of failure, managers can do a better job of anticipating potential trouble spots in their organizations and structuring their initiatives to most effectively offset the risks.

8. What is house of Quality ?

Ans. : House of Quality is a system used to classify customer needs and convert them into definite product features that will satisfy specific needs.

9. Define CPQ.

Ans. : CPQ (Cost of Poor Quality) is the cost or price a company pays when all of its products are not perfect.

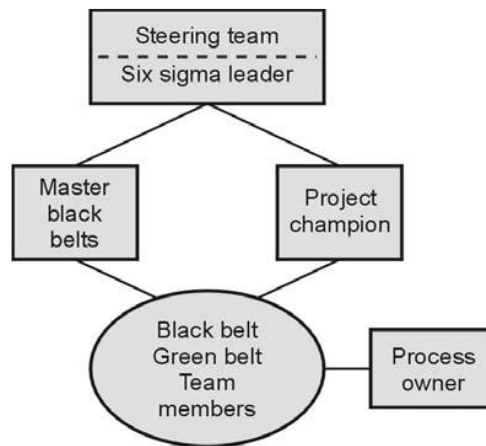
The three different costs are,

- Costs of non-conformities
- Cost of inefficient processes
- Cost of lost opportunities for sales

Companies prefer categorizing CPQ in four different categories and until date, this is the best way how CPQ could be broken down as,

- Internal Failure Cost : Prior to delivery of the product or service
- External Failure Cost : After delivery.
- Prevention Cost : Incurred on prevention activities.
- Appraisal Cost : Incurred by testing, measuring, and auditing.

10. Draw the Structure the deployment of six sigma.



11. Define the cultural challenges that happen in an organization.

Ans. : Those with Six Sigma certification are cultured to see themselves and the work they do differently than traditional employees. They are taught to :

- See work in terms of process flow, and not just departments and functions
- Take an active role in defining improvements and identifying solutions, instead of relying on management
- Utilize the appropriate skills to create and implement solutions
- Actively involve themselves in continuous improvement efforts.

12. What are the Customer/Internal metrics ?

Ans. : Customer metrics need to be supported by a clear description of what it is measuring. They are non-ambiguous and straightforward. The definition, referred to as the constitutive definition, not only tells you what the customer metric is measuring, it also tells you what the customer metric is not measuring.

13. What is MBB ?

Ans. : **MBB** is the Master Black Belt is the Six Sigma Jedi in the organization. Thus, normally the Master Black Belts are the Jedi Council in creating, advising and reviewing the technical parts (syllabus, tools etc) of Six Sigma to meet the organizational needs. The Master Black Belts also responsible to :

- Train and coach the Black Belts and Green Belts
- Help with advanced statistical tools

14. What is a champion training ?

Ans. :

- ☐ Champion training focuses on providing you with the managerial and technical knowledge to facilitate the leadership and deployment of the Six Sigma strategy.
- ☐ Champions are upper-level managers who lead the execution of the Lean Six Sigma deployment plans for the company.
- ☐ That makes it one of the most critical roles in any successful Six Sigma improvement initiative. Guided by the direction set forth by the executive team, champions select the projects, determine who is trained as Black Belts/Green Belts, review progress, and mentor the Black Belts/Green Belts in order for the deployment to be effective.

15. Define close communication system.

Ans. : Communication is a key factor in the success of any project. For Six Sigma leaders, maturity and experience can bring a balance between viewing individual “trees in the forest” and understanding how the whole forest full of trees can function together.

For a Six Sigma project to run smoothly, communication is essential. Hence the close communication system is incorporated among everyone across the organization, which enables to understand the basics of Six Sigma, and then it is more likely there will be some understanding when improvements in one area bring about changes in others.

PART B & C

1. Explain how the supplier input process output customer tool helps in implementing six
2. sigma.
3. Outline the various challenges in six sigma implementation.
4. Discuss the procedure to implement six sigma.
5. Explain in detail about the tools used in six sigma implementation.
6. Write short notes on the following : 1. SIPOC 2. QFD.
7. Explain how to manage project team & Champion Training.
8. Explain in detail about the structure the deployment in six sigma.
9. Discuss on the following topics : 1. Cultural challenges 2. Customer metrics

UNIT V

Evaluation and Continuous Improvement Methods

PART - A

1. Define ROSS.

Ans. : Return on six sigma (ROSS) or otherwise termed as Return on Investment (ROI) is your profit on an investment expressed as a percentage.

$$\text{ROSS} = ((\text{end value} - \text{cost}) / \text{cost})$$

Where :

- ☐ ROI = Return on Investment.
- ☐ End value = Final value of the project.
- ☐ Cost = The amount of money spent on the project.

2. What are the causes for the poor project estimate ?

Ans. : The Causes for poor project estimates are :

- ☐ Lack of experience
- ☐ Business pressure
- ☐ Poor communication
- ☐ Organizational dysfunction

3. Define Lean manufacturing.

Ans. : Lean manufacturing is a methodology that focuses on minimizing waste within manufacturing systems while simultaneously maximizing productivity. Lean manufacturing, also known as lean production, or lean, is a practice that organizations from numerous fields can enable.

4. What are the five principles of Lean manufacturing ?

Ans. : Five principles of lean manufacturing :

- ☐ Identify value from the customer's perspective.
- ☐ Map the value stream
- ☐ Create flow.
- ☐ Establish a pull system
- ☐ Pursue perfection with continual process improvement, or Kaizen

5. Define IIP.

Ans. : It is abbreviated as **Inventory in Process**. Inventory is seen as an asset and often time's suppliers give discount for bulk purchases. But having more inventory than necessary to sustain a steady flow of work can lead to problems including :

- ☐ Product defects or damage materials,
- ☐ Greater lead time in the production process,
- ☐ An inefficient allocation of capital, and
- ☐ Problems being hidden away in the inventory.

Excess inventory can be caused by over-purchasing, overproducing Work In Process (WIP), or producing more products than the customer needs.

6. When does an Overproduction happen ?

Ans. :

- ☐ Overproduction occurs when manufacturing a product or an element of the product before it is being asked for or required.
- ☐ It may be tempting to produce as many products as possible when there is idle worker or equipment time.
- ☐ However, rather than producing products just when they are needed under the 'Just In Time' philosophy, the 'Just In Case' way of working leads a host of problems including preventing smooth flow of work, higher storage costs, hiding defects inside the WIP, requiring more capital expenditure to fund the production process, and excessive lead-time.

7. How to focus on waste ?

Ans. : It takes into account many kinds of waste, including the waste of excessive human motion, and aims to integrate each step of production into a holistic, efficient process that reduces cost and improves overall revenue. Under the lean manufacturing system, seven wastes are identified: overproduction,

- ☐ Inventory,
- ☐ Motion,
- ☐ Defects,
- ☐ Over-processing,
- ☐ Waiting, and
- ☐ Transport

8. What is Takt time ?

Ans. :

- ☐ Takt time is the average time between the start of production of one unit and the start of production of the next unit, when these production starts are set to match the rate of customer demand.
- ☐ It is one of the countermeasures for overproduction.

9. What do you mean by processing waste ?

Ans. : In manufacturing this could include using a higher precision equipment than necessary, using components with capacities beyond what is required, running more analysis than needed, over-engineering a solution, adjusting a component after it has already been installed, and having more functionalities in a product than needed.

10. According to the Overproduction, what is meant to be the 8th waste ?

Ans. : The 8th waste of the overproduction is **Underutilizing People**. This is also described as the waste of unused human talent and ingenuity. This waste occurs when organizations separate the role of management from employees. In some organizations, management's responsibility is planning, organizing, controlling, and innovate the production process.

11. What are the four countermeasures for defects ?

Ans. : Four countermeasures for defects are,

- ☐ Look for the most frequent defect and focus on it.
- ☐ Design a process to detect abnormalities and do not pass any defective items along the production process.
- ☐ Redesign the process so that does not lead to defects.
- ☐ Uses standardize work to ensure a consistent manufacturing process that is defect free.

12. Define Kaizen.

Ans. : Kaizen (Continuous Improvement) is a strategy where employees at all levels of a company work together proactively to achieve regular, incremental improvements to the manufacturing process. In a sense, it combines the collective talents within a company to create a powerful engine for improvement.

13. What are the events that take place in kaizen ?

Ans. :

- ☐ Set goals and provide any necessary background.
- ☐ Review the current state and develop a plan for improvements.

- ☐ Implement improvements.
- ☐ Review and fix what doesn't work.
- ☐ Report results and determine any follow-up items.

14. Define 5S.

Ans. : There are five pillars in 5S in a continuous improvement program, which stand for:

1. Sort (Seiri)
2. Set in Order (Seiton),
3. Shine (Seiso),
4. Standardize (Seiketsu), and
5. Sustain (Shitsuke)

15. What is the need for 5S ?

Ans. :

- ☐ The end result of a 5S implementation is a significant reduction in space needed for existing operations.
- ☐ Workers improve their workspaces by cleaning and organizing them.
- ☐ Tools and materials are labeled and stored in organized storage locations.
- ☐ Shelving and racks optimize the storage of items in a smaller footprint, helping to improve the order picking process by eliminating the need to search for items.

PART B & C

1. Discuss the strategies that evaluate six sigma.
2. What is Return on six sigma (ROSS) and explain with an example.
3. Explain how continuous improvement methods enable six sigma.
4. Discuss the economics of six sigma quality.
5. Explain in detail about Lean manufacturing and the principles applied.
6. Discuss in detail about Overproduction.
7. Explain Kaizen in detail.
8. Discuss 5S with diagram and its need in six sigma.