INDIAN STATISTICAL INSTITUTE
SQC & OR Unit, Hyderabad

MS in Quality Management Science: 2014-16

III SEMESTER: FINAL EXAMINATION

Subject: Six Sigma – Business Excellence Strategies and Problem Solving Framework

Date : 21st October 2015 Max. Marks : 100 Duration: 180 minutes

Instructions

This paper carries 130 marks. Answer as many questions as you can but maximum marks you can score is 100. Question – 3 is compulsory. You need to provide all the answers on the normal answer booklet (Hardcopy). You may provide graphs/charts/diagrams etc. (if any) on the soft answer booklet [word file: Final Exam Answer Booklet (Student name).doc] by clearly writing your name on the answer sheet as well as file name.

1. State whether the following statements are correct or wrong with justification for your answer briefly.

(5x2 = 10 Marks)

a. Six Sigma methodology is not useful for a service industry as a large number of process and product variables are not measurable.

b. Lean Six Sigma is an extension of Six Sigma philosophy for undertaking waste reduction initiatives in an organization.

c. In analyze phase of Six Sigma, the vital causes (X's) of a problem are identified and in the Improve phase they are eliminated to achieve the desired breakthrough improvement.

d. Taguchi philosophy and methods are not applicable in Six Sigma projects when there is no need to conduct any designed experiments.

e. Intelligent application of Statistical Techniques is the key to success in Six Sigma.

2. You are appointed as a Six Sigma Business Analyst in an organization specializing in design, development and manufacture of Nano-chips. The company is having a large R&D establishment and looking for a systematic analysis of the pre-design trials to extract the hidden information in the data.

   You are entrusted with the responsibility of analyzing the available 32 sets of pre-design exploratory data for optimizing wave soldering process (the data set is provided in the excel sheet "Final Exam Data.xls"). The objective of the study is to identify the process parameters which has the potential to reduce the soldering defects per million. Analyze the data with the applicable statistical methods and also as used in a Six Sigma methodology and give your inference on the influential process variables on the defects. Using the influential variables develop a suitable prediction model and predict the optimal process conditions for achieving minimum defects per million.

   (40 Marks)

3. The top management of the above semiconductor industry designing micro-chips for specialty applications decided to develop a Nano-chip for a medical implant device. The R&D chief was asked to develop a robust design to achieve highest levels of reliability.

   The R&D chief has entrusted the responsibility to you for achieving the desired reliability using Six Sigma DFSS approach.

   a. Give a step by step Six Sigma (DFSS – IDDOV) approach you will adopt for design and development of the robust Nano-chip. Whether one can adopt the conventional Six Sigma methodology (DMAIC) for new product development.

   b. Identify the different tools & techniques used in DFSS methodology.

   c. Briefly describe the technique which can effectively be used for generating ideas during the development of different design concepts.

   d. Briefly describe Taguchi's Robust Design methodology as adopted in Six Sigma.

   e. Your DFSS team could finalize a concept and there was a need to optimize the specially designed automatic wave soldering process as a part of the nano-chip development. Due to the complexity associated with the soldering of a number of micro components, the wave soldering process was considered to be the vital for achieving the desired performance and reliability. For developing a robust wave soldering process your team identified five controllable variables each at two levels and three noise variables each at two levels. The response is the number of solder defects per million opportunities.

The factors and their corresponding levels are provided in the following table

Factors and Levels Table				
Factor	Code	Type	Levels	
			1	2
Pre Heat Temp	PHT	Experimental	80	90
Conveyor Speed	CS	Experimental	3	4
Flux Method	FM	Experimental	FF	SF
Solder Temp	ST	Experimental	250	275
Flux Density	FD	Experimental	2.75	3.5
Flux Height	FH	Experimental	1	2
Noise Factors				
Pump Speed	PS	Noise	Low	High
Solder Level	SL	Noise	Min	Max
Conveyer Angle	CA	Noise	Min	Max

The robust optimization study was conducted using the following design.

Robust Design for Optimizing Wave Soldering Process								PS	1	2	2	1
								SL	1	2	1	2
								CA	1	1	2	2
Trial No	Allocation of Factors to Levels							Response (Solder defects per million opportunities)				
	1	2	3	4	5	6	7					
	PHT	CS	PHT x CS	FM	ST	FD	FD x PHT					
1	1	1	1	1	1	1	1	**194**	**197**	**193**	**275**	
2	1	1	1	2	2	2	2	**136**	**136**	**132**	**136**	
3	1	2	2	1	1	2	2	**185**	**261**	**264**	**264**	
4	1	2	2	2	2	1	1	**47**	**125**	**127**	**42**	
5	2	1	2	1	2	1	2	**295**	**216**	**204**	**293**	
6	2	1	2	2	1	2	1	**234**	**159**	**231**	**157**	
7	2	2	1	1	2	2	1	**328**	**326**	**247**	**322**	
8	2	2	1	2	1	1	2	**186**	**187**	**105**	**104**	

(The soft copy of the data is provide in the data file "Final Exam Data.xls")

Identify the design used in the optimization study. What is the advantage of using this type of designs in developing robust products/processes?

Perform analysis of the above experimental data (using both classical method as well as Taguchian method).

Find the optimal wave soldering process conditions to achieve robust and best performance.

Predict the expected solder defects per million opportunities if the optimum conditions recommended by you are implemented.

(60 Marks)

4. Complete the following table by identifying the most appropriate Six Sigma Phase (s) (DMAIC) to which each of these concepts is aligned/associated and the corresponding tools and techniques used to progress in the Six Sigma journey to seek an optimal solution to a given problem.

Sl.No	Concept	Six Sigma Phase(s) (Most appropriate linkage)	Most appropriate Tools/Techniques
1	"Variation is inevitable". Characterization of variation helps in understanding the process statistically.		
2	Prevention is better than Cure and every improvement is reversible.		
3	Every effect is bound to have more than one contributing causes having a distinctive relationship.		
4	Practical problem-Statistical Problem - Statistical Solution – Practical Solution		
5	Measurements alone on process or product are not sufficient to achieve improvements.		

(20 Marks)