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B.E. (Mechanical) Semester- VII (Revised Course 2016-17)  
EXAMINATION NOV/DEC 2019  
Elective - II  
Six Sigma Management

[Time: Three Hours]

[Max. Marks: 100]

- Instructions:**
- 1) Answer 5 questions with atleast 2 from Part A, 2 from Part B and 1 from Part C.
  - 2) Assume suitable missing data.
  - 3) Use of statistical tables permitted.

**PART A**

- Q.1**
- a) Discuss the benefits to organizations when Six Sigma Management is implemented. (08)  
What is new about Six Sigma Management.
  - b) Explain the roles and responsibilities in Six Sigma Management of (12)
    - i) Champion
    - ii) Black belt
    - iii) Process owner
- Q.2**
- a) Using the principles of quality function deployment establish a house of quality for a (10)television set. Establish customer requirements, engineering specifications, relationship matrix, correlations, benchmarking with competitors and conclude appropriately.
  - b) Construct a box and whisker plot of the concentration of suspended solid material (10)from a lake and state your conclusions.

42.4	65.7	29.8	58.7	52.1	55.8
57.0	68.7	67.3	67.3	54.3	54
73.1	81.3	59.9	56.9	62.2	69.9
66.9	59	56.3	43.3	57.4	45.3

- Q.3**
- a) Using the voice of the customer and the voice of the process establish a house of (10)quality for a laundry outlet. Develop the relationship matrix, interrelations, competitive benchmarking and conclude with an appropriate strategy.
  - b) Analyse risk concerns in the road transportation sector using the Failure mode and (10)effects analysis and address significant risks.

**PART B**

**Q.4**

- a) An industrial engineer employed by a beverage bottler is interested in studying the effects of two types of one litre deviations at the neck. The two bottles types (A) are glass and plastic. Two workers are used to perform a task of operating the same machine in different shifts. Four replicates of a  $2^2$  factorial design are performed and the deviations from the target observed are listed below in the following table. Estimate the factor and interaction effects. Perform an ANOVA and identify the significant factors. Which bottle type and which worker would you recommend? (15)

Bottle Type	Worker			
	1	2	3	4
Glass	0.12	0.89	0.65	0.24
	0.98	0	0.49	0.55
Plastic	0.95	0.43	0.28	0.91
	0.27	0.25	0.75	0.71

- b) Explain the Taguchi loss function. (05)

**Q.5**

- a) List out the various phases with the utilized tools in the case study analysis to improve the surface precision of optical lenses. (10)
- b) Discuss DFSS applied in the context of software development. List some challenges encountered during the process. (10)

**Q.6**

- An experimental setup involving L8 orthogonal array to investigate effect of four factors A, B, C and D and their interactions are shown in Table below. The quality characteristic of interest is of lower the better type. Perform a raw data ANOVA to identify the factors which affect the out of roundness. (20)

RUN	FACTORS AND INTERACTIONS							OUT OF ROUNDNESS		
	A	B	AB	C	D	E	ACE	1	2	3
	DXE		BXD							
1	1	1	1	1	1	1	1	13	12	12
2	1	1	1	2	2	2	2	8	10	8
3	1	2	2	1	1	2	2	10	4	8
4	1	2	2	2	2	1	1	10	7	5
5	2	1	2	1	2	1	2	8	12	13
6	2	1	2	2	1	2	1	6	8	8
7	2	2	1	1	2	2	1	2	4	2
8	2	2	1	2	1	1	2	8	8	5

**PART C**

Q.7

- a) An engineer suspects that the surface finish of metal parts is influenced by the type of paint used and the drying time. He selects three drying times – 15, 20 and 25 minutes and two types of paints. The experimental results are tabulated below. State the hypothesis of interest. Test the hypothesis and draw up conclusions using ANOVA with  $\alpha = 0.05$ . Which paint and what drying time would you recommend? (15)

Paint	Drying Time		
	15	20	25
1	75	73	78
	64	60	85
	50	44	90
2	92	95	66
	86	73	45
	70	88	85

- b) Discuss the advantages of FMEA. (05)

Q.8

- a) Construct a Cause and effect diagram analysing addictions. (06)
- b) Using Pareto analyse the data listing non conformities in paint. Draw an appropriate plan of action. (08)

Non-conformity	Frequency
Blister	21
Light spray	38
Drips	22
Overspray	11
Runs	47
Others	5

- c) How does the traditional six sigma process differ from DFSS? (06)



## MECH 7 – (E-I) 5 (RC)

### B.E. (Mech.) (Semester – VII) (RC) Examination, Nov./Dec. 2015 SIX SIGMA MANAGEMENT (Elective – I)

Duration : 3 Hours

Total Marks : 100

**Instructions :** i) Answer any five questions selecting at least one from each Module.

- ii) Use of Statistical Tables allowed.
- iii) Assume missing data, if any.

#### MODULE – I

1. A) Under which circumstances change-over from Three Sigma quality policy to Six Sigma quality policy undertaken ? What are the costs associated with this change-over ? 5

B) Prepare detailed Ishikawa diagram for customer unhappiness in using a manufactured product and explain it in detail. 5

C) The following data are the temperatures of effluent at discharge from a sewage treatment facility on consecutive days. 10

43	47	51	48	52	50	46	49	45	52
46	51	44	49	46	54	49	45	44	50
48	50	49	50	48	46	50	49	46	51

- i) Compute the grouped sample mean and sample standard deviation of the temperature.
- ii) Construct a Histogram of the data and comment on the result.

2. A soft-drink bottler is studying the internal pressure strength of 1-liter glass bottles. A random sample of 16 bottles is tested and the pressure strengths are obtained. The data collected is shown below. Plot these data on regular graph paper. Does it seem reasonable to conclude that pressure strength is normally distributed ?

236	218	221	231
212	205	213	214
229	203	198	212
203	210	234	211

- B) What are the roles and responsibilities of Champion and Black Belt ?  
 C) How was Pareto diagram originated ? What are its applications ?

#### MODULE - II

3. A) In FMEA, explain system definition and identification of failure modes with examples.  
 B) What are the tools, techniques and source of information in process planning phase of QFD ? With an example of drilling of high precision hole in a new component, explain this phase.  
 C) Draw and explain House of Quality for Maggi brand noodles
4. A) With an example of Mobile Call drop problem, explain the complete worksheet of FMEA.  
 B) Explain FMEA for  
   a) Nuclear Power Plants and  
   b) Thermal Power Plants  
 C) What are the applications Quality Function Deployment in service industry ? An Engineering pass-out graduate wants to open a state-of-the art restaurant in coastal belt of Goa. Draw and explain house of quality to start the restaurant keeping in mind the product and service offered

## MODULE – III

5. A) Explain different types of ANOVA. 5  
 B) A process engineer in a chemical plant desires to study the effect of type of reaction time (A) and temperature (B) on a new formulation. Reaction time is studied at 12 hrs. and 18 hrs. and temperature is studied at 25°C and 45°C. Four formulations are studied at each set of conditions as shown below. The response variable is the number of formulation samples meeting specifications as specified by regulator. 15

Trial No.	Factors		Replicate			
	A(hrs.)	B(°C)	I	II	III	IV
1	12	25	34	35	32	40
2	18	25	48	43	40	47
3	12	45	30	28	32	31
4	18	45	70	75	65	77

- a) Estimate the factor effects. Which effects appear to be large ?  
 b) Use the analysis of variance to confirm your conclusions for part (a).  
 c) Based on an analysis of main effect and interaction effect, what levels of A and B would you recommend using ?  
 6. Why S/N ratio is important in Taguchi Methods ? Based on S/N ratio on the data given below, identify significant factors and optimal levels of all the factors. 20

Trial No.	Control factor			Loss (Rs. '000)	
	A	B	C	$y_1$	$y_2$
1	1	1	1	37.8	39.6
2	1	2	2	46.8	48.6
3	1	3	3	57.6	59.4
4	2	1	2	34.2	34.2
5	2	2	3	45.0	46.8
6	2	3	1	39.6	41.4
7	3	1	3	46.8	45.0
8	3	2	1	48.6	48.6
9	3	3	2	54.0	55.8

## MODULE - IV

- AVC
7. A) Elaborate on the improve phase of Six Sigma with example of examination results. 5
- B) Explain Six Sigma approach to improve quality of service in Bank. Emphasize on quality tool and techniques used. 10
- C) Explain the quality improvement tools used in Measure phase of Six Sigma. 5
8. A) Explain the methodology of application of Six Sigma methodology in process design. 10
- B) Explain Six Sigma approach to improve quality of service in College Office. Emphasize on quality tool and techniques used. 10

# MECH 7 – (EI) 6 (RC)

## B.E. (Mechanical) (Semester – VII) (RC 2007-08) Examination, November/December 2017 SIX SIGMA MANAGEMENT (Elective – I)

Duration : 3 Hours

Max. Marks : 100

**Instructions:** 1) Answer five questions with at least one question from each Module.  
2) Assume missing data if any.  
3) Use of statistical tables is permitted.

### MODULE – I

1. A) Discuss with suitable examples the advantages of "Successful Implementation of Six Sigma Management".  
B) Discuss with suitable examples, the roles and responsibilities of Master Black Belt in Six Sigma Management.  
C) What is "Taguchi Loss Function" ? Discuss with suitable examples how Taguchi approach differs from Goal Post Philosophy.
2. A company manufactures export quality semi automatic Milling Machines. Table below presents the number of defects per casting of the machine. Draw a frequency histogram and comment on the distribution. Study the histogram and offer your comments on the number of defects in the castings. Comment on the suitability of using frequency histogram in this situation.

Number of defects in castings	Sample														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	7	3	8	9	8	2	8	11	5	3	8	9	8	3	5
	8	5	6	8	4	3	9	10	6	2	7	8	5	2	4
	4	4	7	5	5	6	10	6	9	1	8	7	4	4	5
	9	6	9	2	8	5	11	5	10	4	9	8	5	3	4
	5	2	6	1	6	7	6	8	12	5	6	9	3	1	3



- B) An automobile industry manufactures engine components. The components are ground on center-less grinder for which the out of roundness of the components is required to be less than 5 microns. Sample 1 of 19 components was taken and it was observed that some components do not meet this requirement.

Machine was handed over to maintenance department. Sample 2 was taken after the maintenance of machine. The out of roundness values are recorded in table below.

**Out of roundness of components in microns**

Component Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
<b>Out of roundness Sample 1</b>	4	8	7	6	9	8	7	9	4	6	10	11	10	9	4	3	9	8	3
<b>Out of roundness Sample 2</b>	3	2	2	4	2	3	2	4	1	3	3	2	3	1	2	2	3	5	2

Draw a Box plot for sample 1 and offer your comments.

- Draw notched box plots (Sample 1 and Sample 2) for 95% confidence level and offer your comments. Take  $C=1.96$  for 95% confidence level.

12

## MODULE – II

3. A) What is House of Quality ? Discuss with suitable examples the situations in which House of Quality can be used. Name Various sections of House of Quality and explain with suitable example how each of these is used. 8
- B) Construct a house of quality for “Executive Chair” for the use of top executives including Managing Directors of Multinational Companies. Discuss how it is used. 12
4. A) What is Fish-bone diagram ? How is it used ? What is FMEA ? How is it used ? Discuss how Fish-bone diagram and FMEA are related. 8
- B) Apply FMEA to failure of a Motorcycle. Explain how FMEA is used in management decisions in this case. 12

### MODULE – III

5. A) A company is having a problem of defective items produced on an injection molding machine. The company has a target of keeping the percentage rejection to below 1%. Based on the brainstorming exercise factors and their levels for study were identified and are tabulated below.

Factor	Levels	
Speed	Low	High
Nozzle	N1	N2

Experiments were conducted and the results are tabulated below :

Trial No.	Factors		Percentage rejection				
	Speed (A)	Nozzle (B)	I	II	III	IV	V
1	Low	N1	1.4	1.6	1.8	1.5	1.7
2	High	N1	0.9	1.2	1.4	1.6	1.1
3	Low	N2	1.2	0.6	0.7	0.6	0.8
4	High	N2	0.1	0.2	0.2	0.3	0.1

- a) Estimate the factor effects. Which effects appear to be large ?  
 b) Use the analysis of variance to confirm your conclusions for part (a).

Based on analysis of main effects and interaction effect, what levels of A and B would you recommend using ? Offer your comments.

- B) Discuss the following in Taguchi Methods : 5
- i) Orthogonal Arrays
  - ii) S/N Ratios.

6. A) An automobile industry is interested in enhancing the surface quality of its machined components. Table below shows the factors and their levels identified for DOE. 15

Factor	Levels	
Speed (A)	Low (1)	High (2)
Feed (B)	Low (1)	High (2)
Tool (C)	HSS (1)	Carbide (2)
Coolant (D)	Low (1)	High (2)



Table below shows the L8 orthogonal array to investigate effects of the four factors on the surface quality of the components. Perform ANOVA to identify the factors and interactions which affect the surface quality of the machined components. Also identify the appropriate setting levels of the main factors.

Trial No.	A	B	AXB	C	CXA	CXB	D	Surface quality % (Higher the better)
1	1	1	1	1	1	1	1	60 62 61 62
2	1	1	1	2	2	2	2	63 65 61 60
3	1	2	2	1	1	2	2	65 68 67 65
4	1	2	2	2	2	1	1	60 61 62 61
5	2	1	2	1	2	1	2	90 91 93 90
6	2	1	2	2	1	2	1	92 93 91 92
7	2	2	1	1	2	2	1	80 83 82 82
818	2	2	1	2	1	1	2	82 83 84 83

- B) Discuss with suitable examples the concept of interactions in DOE. Discuss how you study the effects of interactions in DOE.

5

#### MODULE – IV

7. A) A tourist destination has excellent tourist facilities. The place is well known and has maintained its reputation for over two decades. However it has been observed that the rate of increase of number of tourists has declined over last three years. The customer satisfaction survey also indicates that the satisfaction index has slightly come down. Although the turn over has not reduced, the management has proactively decided to initiate an ambitious plan to increase the customer satisfaction in the coming 3 years from 93% to 96%. Explain the application of Six Sigma Methodology to improve the satisfaction level of the customers. Make necessary assumptions and state the assumptions made. Emphasize on tools and techniques used.

10

- B) A shipbuilding industry is into Barge manufacturing for a decade. It has been extremely successful in this business and is on an ambitious plan of constructing high capacity sea going vessels. The construction of ship involves of Barges. However the standards for high capacity vessels demands reduction of number of cracks per meter in the welds by 50% of the present level. Discuss in detail a step by step DEMAIC approach for reducing the number of defects per meter of weld.

Discuss in detail the tools used in various phases of the approach.

8. A) Discuss with suitable example how Six Sigma approach can be used in a financial co-operative society. Discuss the tools and techniques used.

10

- B) Write a detailed case on Design for Six Sigma highlighting each phase and its importance in designing a Badminton Racket. Highlight tools and techniques while presenting the case.

10

10



## MECH 7 – (E-I) 6 (RC)

**B.E. (Mechanical) (Semester – VII) (Revised Course)**

**Examination, May/June 2017**

**SIX SIGMA MANAGEMENT (Elective – I)**

Duration : 3 Hours

Max. Marks : 100

- Instructions :**
- 1) Answer five questions with atleast one question from each Module.
  - 2) Assume missing data if any.
  - 3) Use of statistical tables is permitted.

### MODULE – I

1. A) What is Six Sigma Management ? Discuss how Six Sigma Management differs from conventional approach. 8  
B) Discuss the Timeline for 6 Sigma Management. 6  
C) Discuss the roles and responsibilities of following in Six Sigma Management. 6
  - i) Champion
  - ii) Process owner.
2. A) What is “Run Chart” ? How are run charts used ? Milling of selector shafts is done on a milling machine using a form cutter. The tolerance for the groove depth is  $5^{+0.05}$ . A fixture is used which supports five shafts at a time. Table below shows the groove depths of the selector shafts. Construct a run chart and comment on whether the process shows common or special causes of variation. Has there been a significant trend ? Offer your comments. 6

Groove depth in mm	Job location in Fixture	Sample						
		1	2	3	4	5	6	7
L1	5.02	5.02	5.02	5.02	5.02	5.03	5.03	
L2	5.01	5.01	5.01	5.02	5.02	5.03	5.03	
L3	5.03	5.03	5.02	5.04	5.04	5.05	5.05	
L4	5.01	5.01	5.01	5.02	5.02	5.03	5.03	
L5	5.03	5.02	5.03	5.04	5.04	5.05	5.05	

- B) An automobile industry uses welding process for manufacturing of brake shoes. Draw a cause and effect diagram for a defective weld. Explain how this diagram is developed and used in addressing the problem of defective weld.

6

- C) The failure time for a semiautomatic machine are recorded in the table below. Plot the data on a normal distribution paper and offer your comments. Estimate the mean and standard deviation for the failure time.

8

### Failure time in days

120	240	180	160	140	220	170	200
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### MODULE – II

3. A) Discuss with suitable examples the following phases in QFD. 8  
 i) Part deployment  
 ii) Process planning.
- B) Construct Hose of quality for Laptop. Discuss how the customer attributes are converted in to engineering characteristics. 12
4. A) What is FMEA ? Discuss with suitable examples the role of FMEA in Six Sigma Mahagement. 8  
 B) Apply FMEA to failure of a Laptop. Explain how FMEA is used in this case. 12

### MODULE – III

5. A) A company is facing a problem of rejection on its offset printing machine. It is felt that the rejection depends on the speed of operation (A) and the quality of paper (B). The experimental study conducted considered speed at two levels, 50 papers per minute (–) and 80 papers per minute (+). Paper quality considered was of two types, ordinary (–) and special (+). The number of defectives per batch of 10000 prints was recorded as shown in table below :

15

Trial No.	Factors		Number of defectives per batch of 10000 prints		
	A	B	I	II	III
1	–	–	280	250	270
2	+	–	360	320	320
3	–	+	180	190	230
4	+	+	310	300	290

c) Estimate the factor effects. Which effects appear to be large ?

d) Use the analysis of variance to confirm your conclusions for Part (a).

Based on an analysis of main effect and interaction effect, what levels of A and B would you recommend for using ? Offer your comments.

B) Discuss the following :

i) Full factorial design

ii) Advantages of fractional factorial designs.

6. A) Table shows the L8 orthogonal array to investigate effects of four factors A, B, C and D on the surface finish of castings produced on a semiautomatic machine. Surface finish is a lower the better type of characteristic. Perform ANOVA to identify the factors and interactions which affect the surface finish of the castings. Also identify the appropriate setting levels of the main factors.

15

Trial No.	A	B	AXB	C	CXA	CXB	D	Surface finish of castings in microns		
1	1	1	1	1	1	1	1	2	2	3
2	1	1	1	2	2	2	2	3	2	3
3	1	2	2	1	1	2	2	2	2	2
4	1	2	2	2	2	1	1	3	2	3
5	2	1	2	1	2	1	2	5	5	6
6	2	1	2	2	1	2	1	4	6	5
7	2	2	1	1	2	2	1	6	6	5
8	2	2	1	2	1	1	2	5	6	6

B) Discuss how you categorize various factors in "Parameter Design".

5

#### MODULE – IV

7. A) A car washing centre is in the business for last one decade. It has good reputation and the feedback from the customers on the service has always remained "Very Good" over the period of time. Recently a competitor has entered the business and it is learnt that the feedbacks obtained by the competitor are "Excellent". The management of the car washing centre is working aggressively to beat the competitor by improving its services Explain the application of Six Sigma Methodology to achieve the objectives of the car washing centre. Emphasise on tools and techniques used.

10



- B) Discuss in detail a step by step DEMAIC approach for reducing the number of defects per meter of weld in a ship building industry. Discuss in detail the tools used in. 10
8. A) Discuss with suitable example how Design for Six Sigma approach and tools can be effectively used in software development environment. Discuss the tools and techniques used. 10
- B) Write a detailed case on Design for Six Sigma highlighting each phase and its importance in designing a canteen for a technical institute. Highlight tools and techniques while presenting the case. 10



## MECH 7 – (E-I) 6 (RC)

### B.E. (Mechanical) (Semester – VII) (Revised Course) Examination, Nov./Dec. 2016 SIX-SIGMA MANAGEMENT (Elective – I)

Duration : 3 Hours

Max. Marks : 100

- Instructions :**
- 1) Answer five questions with at least one question from each Module.
  - 2) Assume missing data if any.
  - 3) Use of statistical tables is permitted.

#### MODULE – I

1. A) Discuss the following in Six Sigma Management. 8  
i) Voice of process                    ii) Voice of Customer.
- B) Discuss the benefits of Six Sigma Management. 6
- C) Discuss with suitable examples the following terms in Six Sigma Management. 6  
i) CTQ                                 ii) Defect Opportunity  
iii) Process Sigma.

2. A) What are "Stem and Leaf Plots" ? Compare Stem and Leaf Plots with Frequency Histograms. 8

A cylindrical casting is having tolerance of  $20^{+0.1}$  mm. Observations of 10 samples are tabulated below.

Draw Stem and Leaf diagram and offer your comments.

Sample	Diameter of casting D in mm (Five per sample)					
1	20.01	20.04	20.00	20.05	20.03	
2	20.05	20.08	20.04	20.09	20.06	
3	20.07	20.03	20.02	20.05	20.07	
4	20.06	20.05	20.04	20.05	20.07	
5	20.05	20.08	20.05	20.04	20.06	
6	20.06	20.02	20.03	20.05	20.06	
7	20.06	20.05	20.07	20.04	20.06	
8	20.03	20.09	20.08	20.02	20.04	
9	20.03	20.05	20.04	20.03	20.07	
10	20.04	20.01	20.02	20.03	20.10	

- B) With a suitable example explain how Pareto diagrams are developed. Discuss how Pareto diagrams are used in Six Sigma management. 6
- C) Discuss measures of central tendency and variation in Normal distribution giving their significance. Explain how these are estimated using Normal Probability Plot. 6

### MODULE – II

3. A) What is QFD ? Name the phases used in QFD and discuss with suitable examples the Product planning phase. 8
- B) Construct House of quality for Washing Machine. Discuss how the roof is constructed and how it is used in this case ? 12
4. A) What is FMEA ? Discuss the applications of FMEA. 8
- B) Apply FMEA to failure of a motorcycle. Explain how FMEA is used in this case ? 12

### MODULE – III

5. A) The number of surface deformities developed on a product during heat treatment process is supposed to be affected by following two factors. 15
- The temperature to which the job is heated (T) and
  - The composition of the material (C)

For experimental design, T is set at two levels : Low (–) and High (+).

Similarly C is set at two levels : Low level of Carbon (–) and High level of Carbon (+).

Four experiments are performed and the number of surface deformities is recorded as shown below.

Trial No.	Factors		Number of Surface Deformities		
	T	C	I	II	III
1	–	–	5	4	4
2	+	–	6	6	7
3	–	+	7	6	7
4	+	+	8	8	9

- a) Estimate the factor effects. Which effects appear to be large ?
- b) Use the analysis of variance to confirm your conclusions for part (a).
- c) Based on an analysis of main effect and interaction effect, what levels of T and C would you recommend using ?

B) With suitable example explain the concept of interactions in design of experiments. How are these studied in ANOVA ?

6. A) A study is undertaken to optimize the output from a machine. Table shows the L8 orthogonal array to investigate effects of four factors A, B, C and D on the output. Perform ANOVA to identify the factors and interactions which affect the output. Also identify the appropriate setting levels of the main factors.

5

15

Trial No.	A	B	AXB	C	CXA	CXB	D	Output from the machine
1	1	1	1	1	1	1	1	300 310 305
2	1	1	1	2	2	2	2	299 300 301
3	1	2	2	1	1	2	2	300 302 305
4	1	2	2	2	2	1	1	299 300 301
5	2	1	2	1	2	1	2	320 325 322
6	2	1	2	2	1	2	1	328 327 325
7	2	2	1	1	2	2	1	330 325 322
8	2	2	1	2	1	1	2	320 326 328

- B) Discuss the concept and use of S/N ratios.

5



## MODULE – IV

7. A) A coaching school in Goa is in to coaching of higher students of science stream. The school has been proud that a high percentage of its students have been getting in to medical and Engineering colleges after XII. However after the start of IIT (Goa) the recent feedback from the students and the parents has indicated that they expect the school to orient the inputs so that the students are better prepared for the Joint Entrance Examination (JEE).

Explain the application of Six Sigma Methodology to achieve the objective of doubling the number of students getting in to IIT every two years. Emphasis on tools and techniques used.

10

- B) Discuss in detail a step by step DEMAIC approach for improvement of surface finish of the shafts turned on a lathe. Discuss in detail the tools used in "Analyse" and "Improve" phases.

10

8. A) Discuss with suitable example how Six Sigma approach can be used in Banking. Discuss the tools and techniques used.

10

- B) Write a detailed case on Design for Six Sigma highlighting each phase and its importance in designing Gymkhana facilities for students of a technical institution. Highlight tools and techniques while presenting the case.

10

**B.E. (Mechanical) (Semester – VII) (RC 2007-08) Examination,  
November/December 2017  
SIX SIGMA MANAGEMENT (Elective – I)**

Duration : 3 Hours

Max. Marks : 100

- Instructions:**
- 1) Answer **five** questions with at least **one** question from **each** Module.
  - 2) Assume missing data if any.
  - 3) Use of statistical tables is **permitted**.

**MODULE – I**

1. A) Discuss with suitable examples the advantages of “Successful Implementation of Six Sigma Management”. **6**  
B) Discuss with suitable examples, the roles and responsibilities of Master Black Belt in Six Sigma Management. **6**  
C) What is “Taguchi Loss Function” ? Discuss with suitable examples how Taguchi approach differs from Goal Post Philosophy. **8**
2. A) A company manufactures export quality semi automatic Milling Machines. Table below presents the number of defects per casting of the machine. Draw a frequency histogram and comment on the distribution. Study the histogram and offer your comments on the number of defects in the castings. Comment on the suitability of using frequency histogram in this situation. **8**

	Sample														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Number of defects in castings	7	3	8	9	8	2	8	11	5	3	8	9	8	3	5
	8	5	6	8	4	3	9	10	6	2	7	8	5	2	4
	4	4	7	5	5	6	10	6	9	1	8	7	4	4	5
	9	6	9	2	8	5	11	5	10	4	9	8	5	3	4
	5	2	6	1	6	7	6	8	12	5	6	9	3	1	3



- B) An automobile industry manufactures engine components. The components are ground on center-less grinder for which the out of roundness of the components is required to be less than 5 microns. Sample 1 of 19 components was taken and it was observed that some components do not meet this requirement.

Machine was handed over to maintenance department. Sample 2 was taken after the maintenance of machine. The out of roundness values are recorded in table below.

**Out of roundness of components in microns**

Component Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Out of roundness Sample 1	4	8	7	6	9	8	7	9	4	6	10	11	10	9	4	3	9	8	3
Out of roundness Sample 2	3	2	2	4	2	3	2	4	1	3	3	2	3	1	2	2	3	5	2

Draw a Box plot for sample 1 and offer your comments.

- Draw notched box plots (Sample 1 and Sample 2) for 95% confidence level and offer your comments. Take  $C=1.96$  for 95% confidence level.

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## MODULE – II

3. A) What is House of Quality ? Discuss with suitable examples the situations in which House of Quality can be used. Name Various sections of House of Quality and explain with suitable example how each of these is used.
- B) Construct a house of quality for “Executive Chair” for the use of top executives including Managing Directors of Multinational Companies. Discuss how it is

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4. A) What is Fish-bone diagram ? How is it used ? What is FMEA ? How is it used ? Discuss how Fish-bone diagram and FMEA are related.
- B) Apply FMEA to failure of a Motorcycle. Explain how FMEA is used in management decisions in this case.

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## MODULE – III

5. A) A company is having a problem of defective items produced on an injection molding machine. The company has a target of keeping the percentage rejection to below 1%. Based on the brainstorming exercise factors and their levels for study were identified and are tabulated below.

Factor	Levels	
Speed	Low	High
Nozzle	N1	N2

Experiments were conducted and the results are tabulated below :

Trial No.	Factors		Percentage rejection				
	Speed (A)	Nozzle (B)	I	II	III	IV	V
1	Low	N1	1.4	1.6	1.8	1.5	1.7
2	High	N1	0.9	1.2	1.4	1.6	1.1
3	Low	N2	1.2	0.6	0.7	0.6	0.8
4	High	N2	0.1	0.2	0.2	0.3	0.1

- a) Estimate the factor effects. Which effects appear to be large ?  
 b) Use the analysis of variance to confirm your conclusions for part (a).  
 Based on analysis of main effects and interaction effect, what levels of A and B would you recommend using ? Offer your comments.

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- B) Discuss the following in Taguchi Methods :

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- i) Orthogonal Arrays
- ii) S/N Ratios.

6. A) An automobile industry is interested in enhancing the surface quality of its machined components. Table below shows the factors and their levels identified for DOE.

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Factor	Levels	
Speed (A)	Low (1)	High (2)
Feed (B)	Low (1)	High (2)
Tool (C)	HSS (1)	Carbide (2)
Coolant (D)	Low (1)	High (2)



Table below shows the L8 orthogonal array to investigate effects of the four factors on the surface quality of the components. Perform ANOVA to identify the factors and interactions which affect the surface quality of the machined components. Also identify the appropriate setting levels of the main factors.

Trial No.	A	B	AXB	C	CXA	CXB	D	Surface quality % (Higher the better)
1	1	1	1	1	1	1	1	60 62 61 62
2	1	1	1	2	2	2	2	63 65 61 60
3	1	2	2	1	1	2	2	65 68 67 65
4	1	2	2	2	2	1	1	60 61 62 61
5	2	1	2	1	2	1	2	90 91 93 90
6	2	1	2	2	1	2	1	92 93 91 92
7	2	2	1	1	2	2	1	80 83 82 82
818	2	2	1	2	1	1	2	82 83 84 83

- B) Discuss with suitable examples the concept of interactions in DOE. Discuss how you study the effects of interactions in DOE. 5

#### MODULE – IV

7. A) A tourist destination has excellent tourist facilities. The place is well known and has maintained its reputation for over two decades. However it has been observed that the rate of increase of number of tourists has declined over last three years. The customer satisfaction survey also indicates that the satisfaction index has slightly come down. Although the turn over has not reduced, the management has proactively decided to initiate an ambitious plan to increase the customer satisfaction in the coming 3 years from 93% to 96%. Explain the application of Six Sigma Methodology to improve the satisfaction level of the customers. Make necessary assumptions and state the assumptions made. Emphasize on tools and techniques used. 10

- B) A shipbuilding industry is into Barge manufacturing for a decade. It has been extremely successful in this business and is on an ambitious plan of constructing high capacity sea going vessels. The construction of ship involves extensive welding. The present quality of welding is acceptable for construction of Barges. However the standards for high capacity vessels demands reduction of number of cracks per meter in the welds by 50% of the present level. Discuss in detail a step by step DEMAIC approach for reducing the number of defects per meter of weld.

Discuss in detail the tools used in various phases of the approach. 10

8. A) Discuss with suitable example how Six Sigma approach can be used in a financial co-operative society. Discuss the tools and techniques used. 10

- B) Write a detailed case on Design for Six Sigma highlighting each phase and its importance in designing a Badminton Racket. Highlight tools and techniques while presenting the case. 10