

Name:	
Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2022

Course: TPM & TQM

Program: M. Tech (HSE)

Course Code: HSFS 8001

Semester: III

Time: 03 hrs.

Max. Marks: 100

Instructions: Use of calculator is permitted

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Explain the role of TPM & TQM for increasing the profitability in any organization? Justify your explanation with suitable example?	4	CO1
Q-2	What is KAIZEN? Briefly explain with suitable example MURA, MUDA and MURI?	4	CO2
Q-3	With the help of suitable example. Draw standard FMEA and explain its uses?	4	CO2
Q-4	Calculate the overall reliability of the "n" series system if each contain "m" parallel identical systems, Assume individual reliability of each subsystem is r?	4	CO3
Q-5	Write the short notes on a) CAPA b) Six Big Losses In TPM	4 (2+2)	CO5

SECTION B
(4Qx10M= 40 Marks)

Q-6	What is process capability? What is its advantage? Draw suitable diagram to explain it? The ice cream that must be served in an ice cream parlor has to be between -15 degrees Celsius and -35 degrees Celsius. The process of refrigeration that keeps the temperature has a standard deviation (SD) of 2 degrees Celsius. And the mean value of this temperature is -25 degrees Celsius. Using these inputs obtain the process capability index (PCI) for this process?	10 (3+7)	CO2																																	
Q-7	a) The data shows the sample mean and range for 10 samples for size 5 each. Find the control limits for mean chart and range chart. <table border="1" data-bbox="252 1552 1166 1689"> <tr> <td>Sample</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> </tr> <tr> <td>Mean</td> <td>21</td> <td>26</td> <td>23</td> <td>18</td> <td>19</td> <td>15</td> <td>14</td> <td>20</td> <td>16</td> <td>10</td> </tr> <tr> <td>Range</td> <td>5</td> <td>6</td> <td>9</td> <td>7</td> <td>4</td> <td>6</td> <td>8</td> <td>9</td> <td>4</td> <td>7</td> </tr> </table> b) The correlation coefficient between height (as measured in feet) versus weight (as measured in pounds) is 0.40. What is the correlation coefficient of height measured in inches versus weight measured in ounces? [12 inches = one foot; 16 ounces = one pounds]	Sample	1	2	3	4	5	6	7	8	9	10	Mean	21	26	23	18	19	15	14	20	16	10	Range	5	6	9	7	4	6	8	9	4	7	10 (5+5)	CO3
Sample	1	2	3	4	5	6	7	8	9	10																										
Mean	21	26	23	18	19	15	14	20	16	10																										
Range	5	6	9	7	4	6	8	9	4	7																										

Q-8	<p>(a) For a certain type of laptops, the length of time between charges of the battery is normally distributed with a mean of 50 hours and a standard deviation of 15 hours. Frank bought one of these laptops then find the probability that the length of time will be between 50 and 70 hours</p> <p>(b) The average number of acres burned by forest and range fires in a large New Mexico County is 4,300 acres per year, with a standard deviation of 750 acres. The distribution of the number of acres burned is normal. What is the probability that between 2,500 and 4,200 acres will be burned in any given year?</p>	10 (5+5)	CO4
Q-9	<p>Write all the clauses and sub-clauses of ISO 9000 Quality Management System? Explain the steps involve in implementation of ISO system in any organization?</p> <p>ii) Write the short notes on the following:</p> <p>a) Mean Time Between Failure-MTBF</p> <p>b) Pareto Priority Index-PPI</p>	10 (6+4)	CO4

SECTION-C
(2Qx20M=40 Marks)

Q-10	<p>a) The table below contains hypothetical shift data of leading manufacturing unit.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #6699CC; color: white;"> <th style="padding: 5px;">Item</th><th style="padding: 5px;">Data</th></tr> </thead> <tbody> <tr> <td style="padding: 5px;">Shift Length</td><td style="padding: 5px;">8 hours = 480 min.</td></tr> <tr> <td style="padding: 5px;">Short Breaks</td><td style="padding: 5px;">2 @ 15 min. = 30 min.</td></tr> <tr> <td style="padding: 5px;">Meal Break</td><td style="padding: 5px;">1 @ 30 min. = 30 min.</td></tr> <tr> <td style="padding: 5px;">Down Time</td><td style="padding: 5px;">47 minutes</td></tr> <tr> <td style="padding: 5px;">Ideal Run Rate</td><td style="padding: 5px;">60 pieces per minute</td></tr> <tr> <td style="padding: 5px;">Total Pieces</td><td style="padding: 5px;">19,271 pieces</td></tr> <tr> <td style="padding: 5px;">Reject Pieces</td><td style="padding: 5px;">423 pieces</td></tr> </tbody> </table> <p>Using these inputs, calculate the following</p> <ol style="list-style-type: none"> 1. Availability, 2. Performance Efficiency, 3. Rate of Quality, 4. Overall Equipment Efficiency <p>b) Using the following summary data, perform a one-way analysis of variance using $\alpha=.01$</p>	Item	Data	Shift Length	8 hours = 480 min.	Short Breaks	2 @ 15 min. = 30 min.	Meal Break	1 @ 30 min. = 30 min.	Down Time	47 minutes	Ideal Run Rate	60 pieces per minute	Total Pieces	19,271 pieces	Reject Pieces	423 pieces	20 (8+12)	CO5
Item	Data																		
Shift Length	8 hours = 480 min.																		
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Meal Break	1 @ 30 min. = 30 min.																		
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	<table border="1"> <thead> <tr> <th>n</th><th>mean</th><th>sd</th></tr> </thead> <tbody> <tr> <td>30</td><td>50.26</td><td>10.45</td></tr> <tr> <td>30</td><td>45.32</td><td>12.76</td></tr> <tr> <td>30</td><td>53.67</td><td>11.47</td></tr> </tbody> </table>	n	mean	sd	30	50.26	10.45	30	45.32	12.76	30	53.67	11.47		
n	mean	sd													
30	50.26	10.45													
30	45.32	12.76													
30	53.67	11.47													
Q-11	<p>a) What is alpha and beta risk associated with sampling? Draw standard OC curve to explain this.</p> <p>b) When is the best time in the product development process to do QFD? What is the difference between "voice of the customer" (VOC) and customer needs? Draw a diagram of "standard QFD "and explain each block of it?</p>	20 (10+10)	CO4												

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.9	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003	.0003
-3.8	.0007	.0007	.0007	.0006	.0006	.0006	.0006	.0005	.0005	.0005
-3.7	.0011	.0010	.0010	.0010	.0009	.0009	.0008	.0008	.0008	.0008
-3.6	.0016	.0015	.0015	.0014	.0014	.0013	.0013	.0012	.0012	.0011
-3.5	.0023	.0022	.0022	.0021	.0020	.0019	.0019	.0018	.0017	.0017
-3.4	.0034	.0032	.0031	.0030	.0029	.0028	.0027	.0026	.0025	.0024
-3.3	.0048	.0047	.0045	.0043	.0042	.0040	.0039	.0038	.0036	.0035
-3.2	.0069	.0066	.0064	.0062	.0060	.0058	.0056	.0054	.0052	.0050
-3.1	.0097	.0094	.0090	.0087	.0084	.0082	.0079	.0076	.0074	.0071
-3.0	.0135	.0131	.0126	.0122	.0118	.0114	.0111	.0107	.0104	.0100
-2.9	.0187	.0181	.0175	.0169	.0164	.0159	.0154	.0149	.0144	.0139
-2.8	.0256	.0248	.0240	.0233	.0226	.0219	.0212	.0205	.0199	.0193
-2.7	.0347	.0336	.0326	.0317	.0307	.0298	.0289	.0280	.0272	.0264
-2.6	.0446	.0453	.0440	.0427	.0415	.0402	.0391	.0379	.0368	.0357
-2.5	.0621	.0604	.0587	.0570	.0554	.0539	.0523	.0508	.0494	.0480
-2.4	.0820	.0798	.0776	.0755	.0734	.0714	.0695	.0676	.0657	.0639
-2.3	.1072	.1044	.1017	.0990	.0964	.0939	.0914	.0889	.0866	.0842
-2.2	.1390	.1355	.1321	.1287	.1255	.1222	.1191	.1160	.1130	.1101
-2.1	.1786	.1743	.1700	.1659	.1618	.1578	.1539	.1500	.1463	.1426
-2.0	.2275	.2222	.2169	.2118	.2068	.2018	.1970	.1923	.1876	.1831
-1.9	.2872	.2807	.2743	.2680	.2619	.2559	.2500	.2442	.2385	.2330
-1.8	.3593	.3515	.3438	.3362	.3288	.3216	.3144	.3074	.3005	.2938
-1.7	.4447	.4436	.4422	.4418	.4403	.4400	.4392	.4386	.4375	.4367
-1.6	.5480	.5370	.5262	.5155	.5050	.4947	.4846	.4746	.4648	.4551
-1.5	.6681	.6552	.6426	.6301	.6178	.6057	.5938	.5821	.5705	.5592
-1.4	.8076	.7927	.7780	.7636	.7493	.7353	.7215	.7078	.6944	.6811
-1.3	.9680	.9510	.9342	.9176	.9012	.8851	.8691	.8534	.8379	.8226
-1.2	.11307	.11314	.11123	.10935	.10749	.10563	.10383	.10204	.10027	.09853
-1.1	.13567	.13350	.13136	.12924	.12714	.12507	.12302	.12100	.11900	.11702
-1.0	.15866	.15625	.15386	.15151	.14917	.14686	.14457	.14231	.14007	.13786
-0.9	.18406	.18141	.17879	.17619	.17361	.17106	.16853	.16602	.16354	.16109
-0.8	.21186	.20897	.20611	.20327	.20045	.19766	.19489	.19215	.18943	.18673
-0.7	.24196	.23885	.23576	.23270	.22965	.22663	.22363	.22065	.21770	.21476
-0.6	.27425	.27093	.26763	.26435	.26109	.25783	.25463	.25143	.24825	.24510
-0.5	.30834	.30503	.30153	.29806	.29460	.29116	.28774	.28434	.28096	.27760
-0.4	.34458	.34090	.33724	.33360	.32997	.32636	.32276	.31918	.31561	.31207
-0.3	.38209	.37828	.37448	.37070	.36693	.36317	.35942	.35569	.35197	.34827
-0.2	.42074	.41683	.41294	.40905	.40517	.40129	.39743	.39358	.38974	.38591
-0.1	.46017	.45620	.45224	.44828	.44433	.44038	.43644	.43251	.42858	.42465
0.0	.50000	.49601	.49202	.48803	.48405	.48006	.47608	.47210	.46812	.46414

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96483	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

		F-table of Critical Values of $\alpha = 0.01$ for $F(df_1, df_2)$																		
		DF1=1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
DF2=1	2	4052.18	4999.50	5403.35	5624.58	5763.65	5858.39	5928.36	5981.07	6022.47	6055.85	6106.32	6157.29	6208.73	6234.63	6260.65	6286.78	6313.03	6339.39	6365.86
2	98.50	99.00	99.17	99.25	99.30	99.33	99.36	99.37	99.39	99.40	99.42	99.43	99.45	99.46	99.47	99.47	99.48	99.49	99.50	
3	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35	27.23	27.05	26.87	26.69	26.60	26.51	26.41	26.32	26.22	26.13	
4	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.37	14.20	14.02	13.93	13.84	13.75	13.65	13.56	13.46	
5	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	10.05	9.89	9.72	9.55	9.47	9.38	9.29	9.20	9.11	9.02	
6	13.75	10.93	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.72	7.56	7.40	7.31	7.23	7.14	7.06	6.97	6.88	
7	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.47	6.31	6.16	6.07	5.99	5.91	5.82	5.74	5.65	
8	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.67	5.52	5.36	5.28	5.20	5.12	5.03	4.95	4.86	
9	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.11	4.96	4.81	4.73	4.65	4.57	4.48	4.40	4.31	
10	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.71	4.56	4.41	4.33	4.25	4.17	4.08	4.00	3.91	
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.40	4.25	4.10	4.02	3.94	3.86	3.78	3.69	3.60	
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.16	4.01	3.86	3.78	3.70	3.62	3.54	3.45	3.36	
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.96	3.82	3.67	3.59	3.51	3.43	3.34	3.26	3.17	
14	8.86	6.52	5.56	5.04	4.70	4.46	4.28	4.14	4.03	3.94	3.80	3.66	3.51	3.43	3.35	3.27	3.18	3.09	3.00	
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.90	3.81	3.67	3.52	3.37	3.29	3.21	3.13	3.05	2.96	2.87	
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.55	3.41	3.26	3.18	3.10	3.02	2.93	2.85	2.75	
17	8.40	6.11	5.19	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.46	3.31	3.16	3.08	3.00	2.92	2.84	2.75	2.65	
18	8.29	6.01	5.09	4.58	4.25	4.02	3.84	3.71	3.60	3.51	3.37	3.23	3.08	3.00	2.92	2.84	2.75	2.66	2.57	
19	8.19	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.93	2.84	2.76	2.67	2.58	2.49	
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.86	2.78	2.70	2.61	2.52	2.42	
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03	2.88	2.80	2.72	2.64	2.55	2.46	2.36	
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98	2.83	2.75	2.67	2.58	2.50	2.40	2.31	
23	7.88	5.66	4.77	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93	2.78	2.70	2.62	2.54	2.45	2.35	2.26	
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89	2.74	2.66	2.58	2.49	2.40	2.31	2.21	
25	7.77	5.57	4.68	4.18	3.86	3.63	3.46	3.32	3.22	3.13	2.99	2.85	2.70	2.62	2.54	2.45	2.36	2.27	2.17	
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	2.96	2.82	2.66	2.59	2.50	2.42	2.33	2.23	2.13	
27	7.68	5.49	4.60	4.11	3.79	3.56	3.39	3.26	3.15	3.06	2.93	2.78	2.63	2.55	2.47	2.38	2.29	2.20	2.10	
28	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.90	2.75	2.60	2.52	2.44	2.35	2.26	2.17	2.06	
29	7.60	5.42	4.54	4.05	3.73	3.50	3.33	3.20	3.09	3.01	2.87	2.73	2.57	2.50	2.41	2.33	2.23	2.14	2.03	
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.47	2.39	2.30	2.21	2.11	2.01	
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.67	2.52	2.37	2.29	2.20	2.11	2.02	1.92	1.81	
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35	2.20	2.12	2.03	1.94	1.84	1.73	1.60	
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19	2.04	1.95	1.86	1.76	1.66	1.53	1.38	
∞	6.64	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.19	2.04	1.88	1.79	1.70	1.59	1.47	1.33	1.00	

n	A₂	D₃	D₄	A₃	B₃	B₄
2	1.88	0	3.27	2.66	0	3.27
3	1.02	0	2.57	1.95	0	2.57
4	0.73	0	2.28	1.63	0	2.27
5	0.58	0	2.11	1.43	0	2.09
6	0.48	0	2.00	1.29	0.03	1.97
7	0.42	0.08	1.92	1.18	0.12	1.88
8	0.37	0.14	1.86	1.10	0.19	1.81
9	0.34	0.18	1.82	1.03	0.24	1.76
10	0.31	0.22	1.78	0.98	0.28	1.72
11	0.29	0.26	1.74	0.93	0.32	1.68
12	0.27	0.28	1.72	0.89	0.35	1.65
13	0.25	0.31	1.69	0.85	0.38	1.62
14	0.24	0.33	1.67	0.82	0.41	1.59
15	0.22	0.35	1.65	0.79	0.43	1.57
16	0.21	0.36	1.64	0.76	0.45	1.55
17	0.20	0.38	1.62	0.74	0.47	1.53
18	0.19	0.39	1.61	0.72	0.48	1.52
19	0.19	0.40	1.60	0.70	0.50	1.50
20	0.18	0.41	1.59	0.68	0.51	1.49