PGDM, 2015-17
Research Methodology
Subject Code: DM-207

Time Allowed: 2 hrs 30 min **Max Marks: 50**

Roll No: _____

Instruction: Students are required to write Roll No on every page of the question paper, writing anything except the Roll No will be treated as **Unfair Means**. All other instructions on the reverse of Admit Card should be followed meticulously.

Section	No. of Questions to attempt	Marks	Marks
A	3 out of 5 (Short Questions)	5 marks each	3*5 = 15
B	2 out of 3 (Long Questions)	10 marks each	2*10 = 20
C	Compulsory Case Study	15 marks	15

Section A

Attempt ANY 3 questions from the 5 questions in this section. **(3 x 5)**

A1. Given below are three statements. Rewrite them as sets of Null & Alternative hypothesis statements. Identify in each case the independent & dependent variables and suggest an appropriate method.

(a) A high spender on cosmetic products visits malls more often than a moderate or a low spender. ..... *(1.5)*

(b) A second family car iis mostly bigger (1400 cc and above) ..... *(1.5)*

(c) Role ambiguity is negatively related to job satisfaction ..... *(2)*

A2. Describe the steps for conducting a marketing research. Also highlight the precautions that need to be exercised at each step to contain errors.

A3. Compare and contrast the following

(a) Nominal and Ordinal Scale ..... *(2.5)*

(b) CRD and RCBD designs of experiment ..... *(2.5)*

A4. List the steps of questionnaire construction.

A5. Validity and Reliability are two main pillars of marketing research. Explain.

Section B

Attempt ANY 2 questions from the 3 questions in this section. **(2 x 10)**

B1. Is the perceived level of responsibility for an action related to the severity of its consequences?

This question was the basis of a study of responsibility in which the subjects read a description of an accident on an interstate highway. The consequences, in terms of cost and injury, were described as either very minor or serious.

A questionnaire was used to rate the degree of responsibility that the subjects believed should be placed on the main figure in the story. Below are the ratings for both the mild-consequences and the severe-consequences groups. High ratings correspond to higher responsibility attributed to the main figure.

If a 0.05 significance level was used, did the study conclude that severe consequences lead to greater attribution of responsibility?

Consequences	Degree of responsibility								Mean	SD
Mild	4	5	3	3	4	1	2	6	3.5	1.6
Severe	4	5	4	6	7	8	6	5	5.63	1.4

B2. This is a regression analysis carried out on data concerning a bank's efforts to reduce the rate of loan defaults. The file contains financial and demographic information on 850 past and prospective customers. A regression is conducted on Credit Card Debt (in '000s) as the dependent variable which is regressed on Household Income (in '000s), Debt to Income ratio (percentage) and Other Debts (in '000s).

Use the SPSS outputs to answer the following questions.

(a) Comment on the model using Model Summary & ANOVA table ..... *(3)*

(b) Write down the regression equation ..... *(2)*

(c) How would you interpret the standardized (β) coefficients? ..... *(2)*

(d) How would you interpret the t-values, 95% CI and the Significance corresponding to each of the independent variables in the model ..... *(3)*

B3. The following is a Factor Analysis done using survey data from questions designed to assess the impact of sleep problems on various aspects of people's lives.

Using the partial outputs from SPSS Factor Analysis run answer the questions that follow.

(a) How would you use the KMO and Bartlett's test? ..... *(2.5)*

(b) What are the communalities? ..... *(2)*

(c) Refer to the Total Variance Explained table; explain and differentiate % Variance in the columns for

i Initial Eigevalues ..... *(1)*

ii Extracted Sum of Square Loadings ..... *(1)*

iii Rotated Sum of Square Loadings ..... *(1)*

(d) Interpret the Scree plot ..... *(2.5)*

Figure 1: **Regression Outputs from SPSS (Bank Loan data)**

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.768[a]	.590	.589	1.36289

a. Predictors: (Constant), Other debt in thousands, Debt to income ratio (x100), Household income in thousands

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2265.384	3	755.128	406.537	.000[b]
	Residual	1571.413	846	1.857		
	Total	3836.797	849			

a. Dependent Variable: Credit card debt in thousands

b. Predictors: (Constant), Other debt in thousands, Debt to income ratio (x100), Household income in thousands

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-1.647	.123		-13.419	.000	-1.888	-1.406
	Household income in thousands	.032	.002	.583	17.180	.000	.028	.036
	Debt to income ratio (x100)	.173	.010	.547	16.576	.000	.153	.194
	Other debt in thousands	-.013	.026	-.020	-.493	.622	-.064	.038

a. Dependent Variable: Credit card debt in thousands

Section C (Case Study)

C1. An engineer is designing a battery for use in a device that will be subjected to some extreme variations in temperature. The only design parameter that he can select at this point is the plate material for the battery, and he has three possible choices. When the device is manufactured and is shipped to the field, the engineer has no control over the temperature extremes that the device will encounter, and he knows from experience that temperature will probably affect the effective battery life. However, temperature can be controlled in the product development laboratory for the purposes of a test.

The engineer decides to test all three plate materials at three temperature levels – 15, 70, and 125°F – because these temperature levels are consistent with the product end-use environment.

Four batteries are tested at each combination of plate material and temperature, and all 36 tests are run in random order.

The experimental design and the resulting observed battery life (in hours) data are shown below. The row and column totals are shown in the margins of the table, and the circled numbers are the cell totals.

(a) Compute the ANOVA table for this experiment. ..... *(8)*

Hint: $\sum_{i=1}^{n}(X_i - \bar{X})^2 = \sum_{i=1}^{n} X_i^2 - n\bar{X}^2$

Also if there are k values going into a marginal, the corresponding

Figure 2: **Factor Analysis outputs from SPSS (Impact of sleep data)**

Communalities

	Initial	Extraction
general health	.352	.408
physical fitness	.406	.773
satisfied with sleep amount	.087	.070
mood	.604	.623
energy level	.562	.533
concent	.674	.884
memory	.573	.587
life sat	.766	.779
overall well-being	.819	.865
relationships	.666	.739

Extraction Method: Principal Axis Factoring.

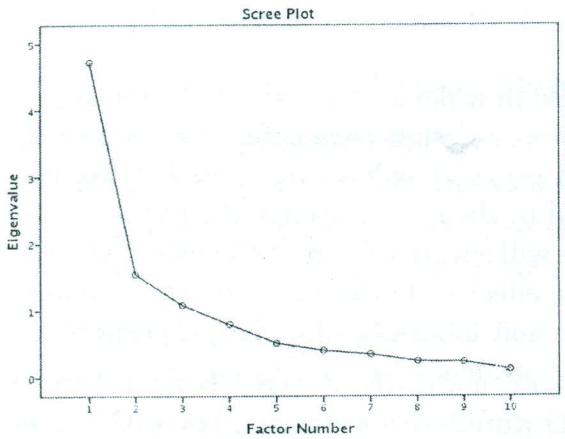
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.822
Bartlett's Test of Sphericity	Approx. Chi-Square	673.817
	df	45
	Sig.	.000

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.723	47.230	47.230	4.448	44.478	44.478	3.157	31.570	31.570
2	1.546	15.456	62.686	1.162	11.621	56.099	1.874	18.743	50.312
3	1.080	10.800	73.486	.651	6.512	62.611	1.230	12.298	62.611
4	.795	7.954	81.440						
5	.514	5.139	86.579						
6	.403	4.028	90.607						
7	.345	3.453	94.060						
8	.244	2.443	96.503						
9	.233	2.331	98.834						
10	.117	1.166	100.000						

Extraction Method: Principal Axis Factoring.



Rotated Factor Matrix[a]

	Factor		
	1	2	3
overall well-being	.875	.311	
life sat	.846	.250	
relationships	.829	.181	-.138
mood	.688	.387	
concent	.383	.851	-.110
memory	.364	.674	
energy level	.473	.516	-.205
satisfied with sleep amount		-.259	
physical fitness		-.141	.863
general health			.639

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

$$SS = k\sum_{i=1}^{n} X_i^2 - n\bar{X}^2$$

Grand average battery life, $\bar{\bar{y}} = \dfrac{3799}{36}$

Average battery life for temperature $15°F$, $\bar{y}_{15°} = \dfrac{1738}{4*3}$

$SS_{Temperature} = 12\ [\bar{y}_{15°}^2 + \bar{y}_{70°}^2 + \bar{y}_{125°}^2] - 36\ \bar{\bar{y}}^2$

Figure 3: Case Study: Battery life

Life Data (in hours) for the Battery Design Experiment

Material Type	Temperature (°F) 15			70			125			$y_{i.}$
1	130 74	155 180	(539)	34 80	40 75	(229)	20 82	70 58	(230)	998
2	150 159	188 126	(623)	136 106	122 115	(479)	25 58	70 45	(198)	1300
3	138 168	110 160	(576)	174 150	120 139	(583)	96 82	104 60	(342)	1501
$y_{.j}$		1738			1291			770		$3799 = y_{..}$

Figure 4: Battery Experiment Data

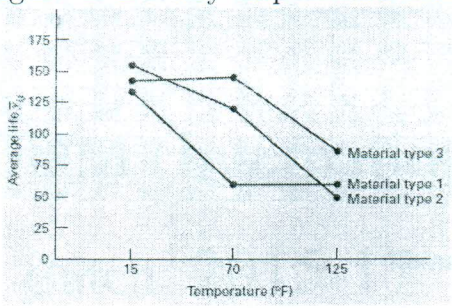


Figure 5: Material type-Temperature plot

(b) Comment on the plot of interaction between material type and temperature (Figure 5), by filling in the blanks in the following analysis report (Page 5). ..... *(7)*

> The significant interaction is indicated by the lack of parallelism of the lines.
> In general, longer life is attained at **(a)** _____ *(low/high)* temperature, regardless of material type. Changing from low to intermediate temperature, battery life with material type 3 may actually **(b)** _____ *(increase/decrease)*, whereas it **(c)** _____ *(increases/decreases)* for types 1 and 2. From intermediate to high temperature, battery life **(d)** _____ *(increases/decreases)* for material types 2 and **(e)** _____ *(1/3)* and is essentially unchanged for type **(f)** _____ *(1/3)*.
> Material type **(g)** _____ *(1/2/3)* seems to give the best results if we want less loss of effective life as the temperature changes.

F Table (Percentage point of F-Distribution (α=0.05)

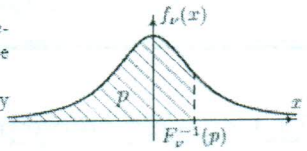
Numerator Degrees of Freedom (Numerator DF)

Denominator Degrees of Freedom	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	Inf.
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88	243.91	245.95	248.01	249.05	250.10	251.14	252.20	253.25	254.25
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.37
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.41
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.85
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.82
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.79
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.74
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.68
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.66
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.63
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.26
Inf.	3.84	3.00	2.61	2.37	2.22	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.40	1.32	1.22	1.05

4 Student's t distribution

Inverse $F_\nu^{-1}(p)$ of the cumulative distribution function (quantiles)

The table below contains the quantiles of Student's t distribution with ν degrees of freedom. For $0 < p < 1$ the quantile is the value of x for which $\mathbb{P}\{X \leq x\} = p$, where $X \sim \mathrm{t}(\nu)$. Thus $x = F_\nu^{-1}(p)$.
The table only contains the quantiles for $p \geq \frac{1}{2}$. For $p < \frac{1}{2}$ quantiles can be obtained by exploiting the symmetry of the t distribution: $F_\nu^{-1}(p) = -F_\nu^{-1}(1-p)$.



ν	p 0.6	0.7	0.75	0.8	0.85	0.9	0.95	0.975	0.99	0.995	0.999	0.9995
1	0.3249	0.7265	1.0000	1.3764	1.9626	3.0777	6.3138	12.706	31.821	63.657	318.31	636.62
2	0.2887	0.6172	0.8165	1.0607	1.3862	1.8856	2.9200	4.3027	6.9646	9.9248	22.327	31.599
3	0.2767	0.5844	0.7649	0.9785	1.2498	1.6377	2.3534	3.1824	4.5407	5.8409	10.215	12.924
4	0.2707	0.5686	0.7407	0.9410	1.1896	1.5332	2.1318	2.7764	3.7469	4.6041	7.1732	8.6103
5	0.2672	0.5594	0.7267	0.9195	1.1558	1.4759	2.0150	2.5706	3.3649	4.0321	5.8934	6.8688
6	0.2648	0.5534	0.7176	0.9057	1.1342	1.4398	1.9432	2.4469	3.1427	3.7074	5.2076	5.9588
7	0.2632	0.5491	0.7111	0.8960	1.1192	1.4149	1.8946	2.3646	2.9980	3.4995	4.7853	5.4079
8	0.2619	0.5459	0.7064	0.8889	1.1081	1.3968	1.8595	2.3060	2.8965	3.3554	4.5008	5.0413
9	0.2610	0.5435	0.7027	0.8834	1.0997	1.3830	1.8331	2.2622	2.8214	3.2498	4.2968	4.7809
10	0.2602	0.5415	0.6998	0.8791	1.0931	1.3722	1.8125	2.2281	2.7638	3.1693	4.1437	4.5869
11	0.2596	0.5399	0.6974	0.8755	1.0877	1.3634	1.7959	2.2010	2.7181	3.1058	4.0247	4.4370
12	0.2590	0.5386	0.6955	0.8726	1.0832	1.3562	1.7823	2.1788	2.6810	3.0545	3.9296	4.3178
13	0.2586	0.5375	0.6938	0.8702	1.0795	1.3502	1.7709	2.1604	2.6503	3.0123	3.8520	4.2208
14	0.2582	0.5366	0.6924	0.8681	1.0763	1.3450	1.7613	2.1448	2.6245	2.9768	3.7874	4.1405
15	0.2579	0.5357	0.6912	0.8662	1.0735	1.3406	1.7531	2.1314	2.6025	2.9467	3.7328	4.0728
16	0.2576	0.5350	0.6901	0.8647	1.0711	1.3368	1.7459	2.1199	2.5835	2.9208	3.6862	4.0150
17	0.2573	0.5344	0.6892	0.8633	1.0690	1.3334	1.7396	2.1098	2.5669	2.8982	3.6458	3.9651
18	0.2571	0.5338	0.6884	0.8620	1.0672	1.3304	1.7341	2.1009	2.5524	2.8784	3.6105	3.9216
19	0.2569	0.5333	0.6876	0.8610	1.0655	1.3277	1.7291	2.0930	2.5395	2.8609	3.5794	3.8834
20	0.2567	0.5329	0.6870	0.8600	1.0640	1.3253	1.7247	2.0860	2.5280	2.8453	3.5518	3.8495
21	0.2566	0.5325	0.6864	0.8591	1.0627	1.3232	1.7207	2.0796	2.5176	2.8314	3.5272	3.8193
22	0.2564	0.5321	0.6858	0.8583	1.0614	1.3212	1.7171	2.0739	2.5083	2.8188	3.5050	3.7921
23	0.2563	0.5317	0.6853	0.8575	1.0603	1.3195	1.7139	2.0687	2.4999	2.8073	3.4850	3.7676
24	0.2562	0.5314	0.6848	0.8569	1.0593	1.3178	1.7109	2.0639	2.4922	2.7969	3.4668	3.7454
25	0.2561	0.5312	0.6844	0.8562	1.0584	1.3163	1.7081	2.0595	2.4851	2.7874	3.4502	3.7251
26	0.2560	0.5309	0.6840	0.8557	1.0575	1.3150	1.7056	2.0555	2.4786	2.7787	3.4350	3.7066
27	0.2559	0.5306	0.6837	0.8551	1.0567	1.3137	1.7033	2.0518	2.4727	2.7707	3.4210	3.6896
28	0.2558	0.5304	0.6834	0.8546	1.0560	1.3125	1.7011	2.0484	2.4671	2.7633	3.4082	3.6739
29	0.2557	0.5302	0.6830	0.8542	1.0553	1.3114	1.6991	2.0452	2.4620	2.7564	3.3962	3.6594
30	0.2556	0.5300	0.6828	0.8538	1.0547	1.3104	1.6973	2.0423	2.4573	2.7500	3.3852	3.6460
31	0.2555	0.5298	0.6825	0.8534	1.0541	1.3095	1.6955	2.0395	2.4528	2.7440	3.3749	3.6335