
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2006/2007

April 2007

MSG 162 – Applied Statistical Methods
[Kaedah Statistik Gunaan]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of FIFTEEN pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMA BELAS muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer **all four** [4] questions.

Arahan: Jawab **semua empat** [4] soalan.]

...2/-

1. (a) It has been hypothesized that different concentrations of fungicides has different effects in controlling wilt in young watermelon plants. Four pots, having seeds infected with the wilt-causing fungus, are randomly assigned to three different fungicides at three different concentrations. The percent of germinated plants surviving to the 48th day were recorded.

Concentration	Fungicide						Total
	A		B		C		
100	8		0		0		61
	33		0		0		
	0		20		0		
	0	41	0	20	0	0	
500	35		33		21		287
	27		33		27		
	54		37		0		
	20	136	0	103	0	48	
1000	100		20		0		525
	40		20		0		
	75		0		50		
	100	315	40	80	80	130	
Total	492		203		178		873

$$\sum \sum Y_{ijk}^2 = 50,065$$

- (i) State an appropriate model and its assumptions.
 - (ii) Do a corresponding analysis at $\alpha = 0.05$.
 - (iii) Perform a follow-up analysis.
- (b) In recent years, domestic car manufacturers have devoted more attention to the small car market. To compare the popularity of four domestic small cars within a city, a local trade organization obtained sales records for five months from four car dealers.

Month	Make of Car				Total
	A	B	C	D	
1	9	27	24	8	68
2	10	30	26	9	75
3	23	25	29	22	99
4	11	12	29	11	63
5	7	28	13	8	56
Total	60	122	121	58	361

$$\sum \sum Y_{ij}^2 = 7,979$$

- (i) State an appropriate model and its assumptions.
- (ii) Do a corresponding analysis at $\alpha = 0.05$.

[28 marks]

.../3-

1. (a) Telah dihipotesiskan bahawa kepekatan racun kulat yang berbeza mempunyai kesan yang berbeza di dalam mengawal pokok tembikai muda daripada layu. Empat buah pasu yang ditanam benih yang dijangkiti kulat penyebab layu diumpukkan secara rawak kepada tiga ubat kulat yang berlainan pada tiga kepekatan yang berlainan. Peratus pokok bercambah yang hidup sehingga ke hari yang keempat puluh lapan dicatat.

Kepekatan	Racun Kulat						Jumlah
	A		B		C		
100	8		0		0		61
	33		0		0		
	0		20		0		
	0	41	0	20	0	0	
500	35		33		21		287
	27		33		27		
	54		37		0		
	20	136	0	103	0	48	
1000	100		20		0		525
	40		20		0		
	75		0		50		
	100	315	40	80	80	130	
Jumlah	492		203		178		873

$$\sum \sum Y_{ijk}^2 = 50,065$$

- (i) Nyatakan model yang sesuai serta anggapannya.
 (ii) Lakukan suatu analisis yang sepadan pada $\alpha = 0.05$.
 (iii) Lakukan suatu tatacara lanjutan.
- (b) Pada beberapa tahun kebelakangan ini, pengusaha kereta domestik telah menumpukan lebih perhatian kepada pasaran kereta kecil. Untuk membandingkan kegemaran terhadap empat jenis kereta kecil domestik di dalam suatu bandaraya, sebuah organisasi perniagaan tempatan mendapatkan rekod jualan bagi lima bulan daripada empat buah syarikat penjual kereta.

Bulan	Jenis Buatan Kereta				Jumlah
	A	B	C	D	
1	9	27	24	8	68
2	10	30	26	9	75
3	23	25	29	22	99
4	11	12	29	11	63
5	7	28	13	8	56
Jumlah	60	122	121	58	361

$$\sum \sum Y_{ij}^2 = 7,979$$

- (i) Nyatakan model yang sesuai serta anggapannya.
 (ii) Lakukan suatu analisis yang sepadan pada $\alpha = 0.05$.

[28 markah]

2. (a) A large supermarket chain has its own store brand for many grocery items. These tend to be priced lower than other brands. For a particular item, the chain wants to study the effect of varying the price for the major competing brand on the sales of the store brand item, while the prices for the store brand and all other brands are held fixed. The experiment is conducted at one of the chain's stores over a 7-week period.

Week	Store brand sales	Competitor's price (cents)
1	122	37
2	107	32
3	99	29
4	110	35
5	113	33
6	104	31
7	116	35

$$\sum(\text{store}) = 771$$

$$\sum(\text{store})^2 = 85,275$$

$$\sum(\text{competitor}) = 232$$

$$\sum(\text{competitor})^2 = 7,734$$

$$\sum(\text{store})(\text{competitor}) = 25,672$$

- (i) Perform appropriate analysis to obtain the model and its assumptions. Use $\alpha = 0.01$.
- (ii) Suppose the competitor's price is set at 33 cents. Obtain an estimation interval and a prediction interval.
- (b) Weevils cause millions of dollars worth of damage each year to cotton crops. Three chemicals (A, B and C), designed to control weevil populations were randomly selected and randomly assigned to each of three fields of cotton. After 3 months, 6 plots of equal sizes were selected within each field and the percentage of cotton plants with weevil damage was recorded.

Plot	Chemical			Total
	A	B	C	
1	9.8	22.3	9.8	41.9
2	16.7	18.6	15.3	50.6
3	19.0	19.5	17.3	55.8
4	20.3	23.6	16.2	60.1
5	15.0	24.3	12.1	51.4
6	10.8	22.6	11.3	44.7
Total	91.6	130.9	82.0	304.5

$$\sum \sum Y_{ij}^2 = 5,537.33$$

- (i) State an appropriate model and its assumptions.
- (ii) Do a corresponding analysis at $\alpha = 0.01$.

[28 marks]

.../5-

2. (a) Sebuah pasaraya berangkai yang besar mempunyai jenama sendiri bagi pelbagai barangan makanan. Barang-barang ini biasanya mempunyai harga lebih rendah daripada jenama yang lain. Bagi suatu barangan tertentu, pasaraya ini ingin mengkaji kesan perubahan harga barangan jenama pesaing utama terhadap jualan barangan jenama sendiri, manakala harga barangan jenama sendiri serta barangan jenama lain tidak berubah. Ujikaji ini dilakukan di salah sebuah rangkaian pasaraya tersebut untuk suatu tempoh selama tujuh minggu.

Minggu	Jualan Jenama Pasaraya	Harga Pesaing (sen)
1	122	37
2	107	32
3	99	29
4	110	35
5	113	33
6	104	31
7	116	35

$$\Sigma(\text{pasaraya}) = 771$$

$$\Sigma(\text{pasaraya})^2 = 85,275$$

$$\Sigma(\text{pesaing}) = 232$$

$$\Sigma(\text{pesaing})^2 = 7,734$$

$$\Sigma(\text{pasaraya})(\text{pesaing}) = 25,672$$

- (i) Lakukan analisis yang sesuai untuk mendapatkan suatu model serta anggapannya. Guna $\alpha = 0.01$.
- (ii) Andaikan harga pesaing diletakkan sebagai 33 sen. Dapatkan suatu selang anggaran dan suatu selang ramalan.
- (b) Kumbang menyebabkan kerugian bernilai berjuta-juta dollar setiap tahun pada tanaman kapas. Tiga bahan kimia (A, B dan C) dirangka untuk mengawal populasi kumbang dipilih secara rawak dan diumpukkan secara rawak kepada setiap satu daripada tiga ladang kapas. Setelah 3 bulan, 6 buah plot yang bersaiz sama dipilih daripada setiap ladang dan peratus pokok kapas yang dirosakkan kumbang dicatat.

Plot	Bahan Kimia			Jumlah
	A	B	C	
1	9.8	22.3	9.8	41.9
2	16.7	18.6	15.3	50.6
3	19.0	19.5	17.3	55.8
4	20.3	23.6	16.2	60.1
5	15.0	24.3	12.1	51.4
6	10.8	22.6	11.3	44.7
Jumlah	91.6	130.9	82.0	304.5

$$\Sigma \Sigma Y_{ij}^2 = 5,537.33$$

- (i) Nyatakan model yang sesuai serta anggapannya.
- (ii) Lakukan suatu analisis yang sepadan pada $\alpha = 0.01$.

[28 markah]

3. (a) Four types of gasoline additives were tested for petrol consumption on four cars, car A, car B, car C and, car D, of different make but of the same class.

Additive 1: Additive type A, made by manufacturer I

Additive 2: Additive type B, made by manufacturer I

Additive 3: Additive type A, made by manufacturer II

Additive 4: Additive type B, made by manufacturer II

Four cars are randomly selected from each make and randomly assigned to each of the four types of additives. A gallon of gasoline was added to an empty tank and the car was driven without stopping until it ran out of gasoline. The results (in miles per gallon) are recorded.

Additives	Car				Total
	A	B	C	D	
1	19.5	20.3	19.4	21.3	80.5
2	18.0	17.8	17.8	15.8	69.4
3	18.5	19.6	20.3	18.8	77.2
4	21.1	22.8	21.7	21.6	87.2
Total	77.1	80.5	79.2	77.5	314.3

$$\sum \sum Y_{ij}^2 = 6,224.15$$

- (i) State an appropriate model and its assumptions.
 - (ii) Do a corresponding analysis at $\alpha = 0.01$.
 - (iii) Perform a follow-up analysis using Duncan multiple range test.
 - (iv) Determine the following effects on petrol consumption:
 - a. using additive type A and additive type B
 - b. using additive by manufacturer I and additive by manufacturer II
- (b) When student seating in a large lecture course is by personal choice, is seat location correlated to a student's grade? In particular, do students who choose seats in the front of the classroom tend to obtain better grades than those who choose the back? The grades of eight randomly selected statistics students are given here along with their row location (number from the front of the classroom).

Student	Grade	Row
1	93	7
2	78	1
3	89	4
4	98	3
5	66	25
6	78	9
7	55	30
8	85	13
Total	642	92

Do an appropriate analysis using at $\alpha = 0.01$.

[30 marks]

3. (a) Empat jenis aditif petrol diuji untuk penggunaan petrol keatas empat buah kereta, kereta A, kereta B, kereta C dan kereta D, yang jenamanya berlainan tetapi di dalam kelas yang sama.

Aditif 1: Aditif jenis A, dibuat oleh pengusaha I

Aditif 2: Aditif jenis B, dibuat oleh pengusaha I

Aditif 3: Aditif jenis A, dibuat oleh pengusaha II

Aditif 4: Aditif jenis B, dibuat oleh pengusaha II

Empat buah kereta dipilih daripada setiap jenama dan diumpukkan secara rawak kepada setiap daipada empat jenis aditif. Segelen petrol diisi ke dalam tangki kosong dan kereta tersebut dipandu tanpa berhenti sehingga ia kehabisan petrol. Keputusannya (di dalam batu per gelen) dicatat.

Aditif	Kereta				Jumlah
	A	B	C	D	
1	19.5	20.3	19.4	21.3	80.5
2	18.0	17.8	17.8	15.8	69.4
3	18.5	19.6	20.3	18.8	77.2
4	21.1	22.8	21.7	21.6	87.2
Jumlah	77.1	80.5	79.2	77.5	314.3

$$\sum \sum Y_{ij}^2 = 6,224.15$$

- (i) Nyatakan suatu model yang sesuai serta anggapan.
- (ii) Lakukan suatu analisis yang sesuai pada $\alpha = 0.01$.
- (iii) Lakukan suatu tatacara lanjutan dengan ujian julat berganda Duncan.
- (iv) Tentukan kesan berikut ke atas penggunaan petrol::
- menggunakan aditif jenis A and aditif jenis B
 - menggunakan aditif pengusaha I dan aditif pengusaha II
- (b) Apabila seseorang pelajar duduk di dalam sebuah kuliah bagi kursus yang bersaiz besar mengikut pilihannya sendiri, adakah lokasi kedudukan berkorelasi dengan gred seseorang pelajar? Khususnya, adakah pelajar-pelajar yang memilih duduk di hadapan kelas cenderung untuk mendapat gred yang lebih baik daripada mereka yang memilih duduk di belakang. Gred bagi sepuluh orang pelajar statistik yang dipilih secara rawak diberi bersama dengan lokasi baris mereka (nombor bermula daripada hadapan kelas).

Pelajar	Gred	Baris
1	93	7
2	78	1
3	89	4
4	98	3
5	66	25
6	78	9
7	55	30
8	85	13
Jumlah	642	92

Lakukan suatu analisis yang sesuai pada $\alpha = 0.01$.

[30 markah]

4. Suatu kajian dilakukan untuk menilai kesan beberapa factor keatas tekanan darah. Dua pembolehubah yang dianggap penting ialah umur dan berat badan individu. Data dicatat daripada suatu sampel yang terdiri daripada orang lelaki dewasa:

Umur (di dalam tahun)	Berat Badan (di dalam paun)	Tekanan Darah
48	175	139
50	159	131
35	191	135
41	174	131
33	165	121
25	157	115
51	182	133
53	164	129

Rujuk pada lampiran output untuk soalan 4.

- (i) Lakukan analisis yang sesuai untuk mendapatkan suatu model serta anggapannya. Guna $\alpha = 0.05$.
- (ii) Dapatkan suatu selang anggaran dan suatu selang ramalan jika seorang lelaki dewasa berumur 45 tahun dan mempunyai berat badan 180 paun.

[14 markah]

APPENDIX: TABLES

Duncan Multiple Range Table

VII. Significant Ranges for Duncan's Multiple Range Test^a

$r_{.01}(p, f)$

<i>f</i>	<i>p</i>											
	2	3	4	5	6	7	8	9	10	20	50	100
1	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
3	8.26	8.5	8.6	8.7	8.8	8.9	8.9	9.0	9.0	9.3	9.3	9.3
4	6.51	6.8	6.9	7.0	7.1	7.1	7.2	7.2	7.3	7.5	7.5	7.5
5	5.70	5.96	6.11	6.18	6.26	6.33	6.40	6.44	6.5	6.8	6.8	6.8
6	5.24	5.51	5.65	5.73	5.81	5.88	5.95	6.00	6.0	6.3	6.3	6.3
7	4.95	5.22	5.37	5.45	5.53	5.61	5.69	5.73	5.8	6.0	6.0	6.0
8	4.74	5.00	5.14	5.23	5.32	5.40	5.47	5.51	5.5	5.8	5.8	5.8
9	4.60	4.86	4.99	5.08	5.17	5.25	5.32	5.36	5.4	5.7	5.7	5.7
10	4.48	4.73	4.88	4.96	5.06	5.13	5.20	5.24	5.28	5.55	5.55	5.55
11	4.39	4.63	4.77	4.86	4.94	5.01	5.06	5.12	5.15	5.39	5.39	5.39
12	4.32	4.55	4.68	4.76	4.84	4.92	4.96	5.02	5.07	5.26	5.26	5.26
13	4.26	4.48	4.62	4.69	4.74	4.84	4.88	4.94	4.98	5.15	5.15	5.15
14	4.21	4.42	4.55	4.63	4.70	4.78	4.83	4.87	4.91	5.07	5.07	5.07
15	4.17	4.37	4.50	4.58	4.64	4.72	4.77	4.81	4.84	5.00	5.00	5.00
16	4.13	4.34	4.45	4.54	4.60	4.67	4.72	4.76	4.79	4.94	4.94	4.94
17	4.10	4.30	4.41	4.50	4.56	4.63	4.68	4.73	4.75	4.89	4.89	4.89
18	4.07	4.27	4.38	4.46	4.53	4.59	4.64	4.68	4.71	4.85	4.85	4.85
19	4.05	4.24	4.35	4.43	4.50	4.56	4.61	4.64	4.67	4.82	4.82	4.82
20	4.02	4.22	4.33	4.40	4.47	4.53	4.58	4.61	4.65	4.79	4.79	4.79
30	3.89	4.06	4.16	4.22	4.32	4.36	4.41	4.45	4.48	4.65	4.71	4.71
40	3.82	3.99	4.10	4.17	4.24	4.30	4.34	4.37	4.41	4.59	4.69	4.69
60	3.76	3.92	4.03	4.12	4.17	4.23	4.27	4.31	4.34	4.53	4.66	4.66
100	3.71	3.86	3.98	4.06	4.11	4.17	4.21	4.25	4.29	4.48	4.64	4.65
∞	3.64	3.80	3.90	3.98	4.04	4.09	4.14	4.17	4.20	4.41	4.60	4.68

f = degrees of freedom.

^aReproduced with permission from "Multiple Range and Multiple F Tests," by D. B. Duncan, *Biometrics*, Vol. 1, No. 1, pp. 1-42, 1955.

Spearman Table

Table A.19 Critical values of the Spearman test statistic; approximate upper-tail critical values r_s^* , where $P(r_s > r_s^*) \leq \alpha$, $n = 4(1)30$; significance level, α

n	.001	.005	.010	.025	.050	.100
4	—	—	—	—	.8000	.8000
5	—	—	.9000	.9000	.8000	.7000
6	—	.9429	.8857	.8286	.7714	.6000
7	.9643	.8929	.8571	.7450	.6786	.5357
8	.9286	.8571	.8095	.7143	.6190	.5000
9	.9000	.8167	.7667	.6833	.5833	.4667
10	.8667	.7818	.7333	.6364	.5515	.4424
11	.8364	.7545	.7000	.6091	.5273	.4182
12	.8182	.7273	.6713	.5804	.4965	.3986
13	.7912	.6978	.6429	.5549	.4780	.3791
14	.7670	.6747	.6220	.5341	.4593	.3626
15	.7464	.6536	.6000	.5179	.4429	.3500
16	.7265	.6324	.5824	.5000	.4265	.3382
17	.7083	.6152	.5637	.4853	.4118	.3260
18	.6904	.5975	.5480	.4716	.3994	.3148
19	.6737	.5825	.5333	.4579	.3895	.3070
20	.6586	.5684	.5203	.4451	.3789	.2977
21	.6455	.5545	.5078	.4351	.3688	.2909
22	.6318	.5426	.4963	.4241	.3597	.2829
23	.6186	.5306	.4852	.4150	.3518	.2767
24	.6070	.5200	.4748	.4061	.3435	.2704
25	.5962	.5100	.4654	.3977	.3362	.2646
26	.5856	.5002	.4564	.3894	.3299	.2588
27	.5757	.4915	.4481	.3822	.3236	.2540
28	.5660	.4828	.4401	.3749	.3175	.2490
29	.5567	.4744	.4320	.3685	.3113	.2443
30	.5479	.4665	.4251	.3620	.3059	.2400

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