
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2010/2011 Academic Session

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MAT 161 – Elementary Statistics
[Statistik Permulaan]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of ELEVEN pages of printed materials before you begin the examination.

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

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

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

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai].

1. (a) 100 people were asked to record the number of television programs they watched in a week. The results were as follows:

Number of programs	0-	10-	18-	30-	35-	45-	50-	60-
Number of viewers	3	16	36	21	12	9	3	0

- (i) Obtain the percentile rank of 40 programs watched per week.
- (ii) Calculate the minimum number of viewers that watched more than 15 programs per week.
- (iii) Find the median number of programs watched by 10% of the viewers with the highest number of programs watched in a week.
- (b) A factory produces electronic equipments and receives 40% of the supplies from supplier A, 25% from supplier B, and 35% from supplier C. The percentage of faulty components produced by supplier A, B and C are respectively 5%, 2% and 1%
- (i) Find the probability that from two electronic components chosen at random from all suppliers, at least one component is faulty.
- (ii) An electronic component chosen is faulty, what is the probability that it is from supplier A?
- (c) Cars arrive at a petrol station at an average rate of 30 per hour. Find the probability that in one hour, there are less than 30 cars arrive at the petrol station.
Find the probability that in a five-hour period which is chosen randomly, there are at most 3 hours that less than 30 cars arrive at the petrol station.

[25 marks]

1. (a) 100 orang diminta untuk mencatat bilangan program televisyen yang mereka tonton dalam seminggu. Hasilnya adalah seperti berikut:

Bilangan program	0-	10-	18-	30-	35-	45-	50-	60-
Bilangan penonton	3	16	36	21	12	9	3	0

- (i) Dapatkan pangkat persentil bagi 40 program yang ditonton seminggu.
- (ii) Kira bilangan penonton minimum yang menonton lebih daripada 15 program seminggu.
- (iii) Cari median bilangan program yang ditonton oleh 10% daripada penonton dengan bilangan program yang tertinggi ditonton dalam seminggu.
- (b) Sebuah kilang menghasilkan alat elektronik dan menerima 40% bekalannya daripada pembekal A, 25% daripada pembekal B, dan 35% daripada pembekal C. Peratusan komponen rosak dihasilkan oleh pembekal A, B dan C masing-masing adalah 5%, 2% dan 1%.
- (i) Cari kebarangkalian bahawa daripada dua komponen elektronik yang dipilih secara rawak daripada kesemua pembekal, sekurang-kurangnya satu komponen rosak.
- (ii) Suatu komponen elektronik yang dipilih adalah rosak, apakah kebarangkalian bahawa ianya daripada pembekal A?
- (c) Kereta tiba di sebuah stesen minyak pada suatu kadar purata 30 sejam. Cari kebarangkalian bahawa dalam satu jam, terdapat kurang daripada 30 kereta tiba di stesen minyak tersebut.
Cari kebarangkalian bahawa dalam suatu tempoh lima jam yang dipilih secara rawak, terdapat paling lama 3 jam bahawa kurang daripada 30 kereta tiba di stesen minyak tersebut.

[25 markah]

2. (a) A highway patrol police was interested in knowing whether frequent patrolling of highways substantially reduces the number of speeders. Two similar interstate highways were selected for the study, one heavily patrolled and the other only occasionally patrolled. After one month, random samples of 100 cars were chosen on each highway and the number of cars exceeding the speed limit was recorded on five randomly selected days.

Day	Highway 1 (Heavily patrolled)	Highway 2 (Occasionally patrolled)	Total
1	35	60	95
2	40	45	85
3	25	48	73
4	38	54	92
5	47	63	110
Total	185	270	455

$$\sum_i \sum_j Y_{ij}^2 = 21,917$$

- (i) State the appropriate assumptions.
(ii) Test for equal variances if it is needed at $\alpha = 0.01$.
(iii) Perform an appropriate statistical analysis. Use $\alpha = 0.01$.
- (b) Due to rapid changes in technology, personal computers tend to become obsolete within a few years. The following information gives the average estimated useful lives (in years) of personal computers for the years 1993 through 2005.

Year	1993	1994	1995	1996	1997	1998	1999
Average useful life	4.2	4.1	3.8	3.6	3.4	3.2	3.1

Year	2000	2001	2002	2003	2004	2005
Average useful life	2.8	2.6	2.4	2.2	2.1	2.0

Is there evidence to indicate that the useful lives of personal computers changes? Use $\alpha = 0.10$

- (c) A firm investigated the number of employees suffering injuries whilst at work. The results recorded were obtained for a 52-week period:

Number of employees injured in a week	0	1	2	3	4 or more	Total
Number of weeks	31	17	3	1	0	52

- (i) What is a reasonable probability model for this type of data?
(ii) Test if this model adequately describes the data. Use $\alpha = 0.01$.

[25 marks]

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2. (a) Seorang polis peronda lebuhraya ingin mengetahui sama ada kekerapan meronda lebuhraya dapat mengurangkan bilangan pemandu laju dengan berkesan. Dua lebuhraya antara negeri yang sama dipilih untuk kajian, satu dironda kerap dan satu lagi hanya dironda sekali-sekala. Selepas sebulan, sampel rawak 100 kereta dipilih bagi setiap lebuhraya tersebut dan bilangan kereta melebihi had laju dicatat pada lima hari yang dipilih secara rawak.

Hari	Lebuhraya 1 (Dironda kerap)	Lebuhraya 2 (Dironda sekali-sekala)	Jumlah
1	35	60	95
2	40	45	85
3	25	48	73
4	38	54	92
5	47	63	110
Jumlah	185	270	455

$$\sum_i \sum_j Y_{ij}^2 = 21,917$$

- (i) Nyatakan anggapan-anggapan.
(ii) Uji kesamaan varians jika diperlukan pada $\alpha = 0.01$.
(iii) Lakukan suatu analisis statistik yang sesuai. Guna $\alpha = 0.01$.
- (b) Disebabkan perubahan pantas dalam teknologi, komputer peribadi berkemungkinan menjadi lupus dalam beberapa tahun. Maklumat berikut memberi anggaran purata hayat berguna (dalam tahun) komputer peribadi bagi tahun 1993 sehingga 2005.

Tahun	1993	1994	1995	1996	1997	1998	1999
Purata hayat berguna	4.2	4.1	3.8	3.6	3.4	3.2	3.1

Tahun	2000	2001	2002	2003	2004	2005
Purata hayat berguna	2.8	2.6	2.4	2.2	2.1	2.0

Adakah terdapat bukti untuk menunjukkan bahawa purata hayat berguna komputer peribadi berubah? Guna $\alpha = 0.10$.

- (c) Sebuah firma mengkaji bilangan pekerja yang menderita kecederaan semasa bekerja. Hasil yang dicatat didapati untuk tempoh 52-minggu.

Bilangan pekerja yang cedera dalam seminggu	0	1	2	3	4 atau lebih	Jumlah
Bilangan minggu	31	17	3	1	0	52

- (i) Apakah model kebarangkalian yang sesuai bagi jenis data tersebut?
(ii) Uji jika model tersebut memberihal data secukupnya. Guna $\alpha = 0.01$.

[25 markah]

3. (a) Two different treatment programs were designed to produce a weight loss by focusing on either diet or behaviour modification. Eight overweight individuals were selected and randomly assigned to each of the treatment program. After participating in the program for two months, the weight changes (to the nearest kilogram) were recorded.

Individual	Diet	Behaviour modification	Total
1	3	7	10
2	4	1	5
3	0	20	20
4	-1	0	-1
5	5	22	27
6	20	18	38
7	3	4	7
8	0	6	6
Total	34	78	112

$$\sum_i \sum_j Y_{ij}^2 = 1,770$$

- (i) State the appropriate assumptions.
(ii) Test for equal variances if it is needed at $\alpha = 0.02$.
(iii) Perform an appropriate statistical analysis. Use $\alpha = 0.02$.
- (b) A new insect spray, type A, is to be tested with a spray, type B, that is currently in use. Two rooms of equal size are sprayed with the same amount of spray, one room with A, the other with B. Two hundreds insects are released into each room and after 1 hour, the number of dead insects are counted.

	Spray A	Spray B
Number of insects released	200	200
Number of dead insects	120	80

- (i) State the appropriate assumptions.
(ii) Perform an appropriate statistical analysis. Use $\alpha = 0.02$.

[25 marks]

3. (a) Dua program latihan berlainan dirangka untuk menghasilkan pengurangan berat badan dengan menumpukan kepada perubahan tabiat. Lapan individu berlebihan berat badan dipilih dan diumpukkan secara rawak kepada setiap daripada program rawatan. Selepas menghadiri program tersebut selama dua bulan, perubahan berat badan (ke kilogram terhampir) dicatat.

Individu	Diet	Perubahan tabiat	Jumlah
1	3	7	10
2	4	1	5
3	0	20	20
4	-1	0	-1
5	5	22	27
6	20	18	38
7	3	4	7
8	0	6	6
Jumlah	34	78	112

$$\sum_i \sum_j Y_{ij}^2 = 1,770$$

- (i) Nyatakan anggapan-anggapannya.
(ii) Uji kesamaan varians jika diperlukan pada $\alpha = 0.02$.
(iii) Lakukan suatu analisis statistik yang sesuai. Guna $\alpha = 0.02$.
- (b) Suatu semburan serangga baru, jenis A, diuji dengan suatu semburan, jenis B, yang digunakan sekarang. Dua bilik yang bersaiz sama disemur dengan jumlah semburan sama, satu bilik dengan A, dan yang satu lagi dengan B. Dua ratus serangga dilepaskan ke dalam setiap bilik dan selepas sejam, bilangan serangga yang mati dikira.

	Semburan A	Semburan B
Bilangan serangga dilepaskan	200	200
Bilangan serangga yang mati	120	80

- (i) Nyatakan anggapan-anggapannya.
(ii) Lakukan suatu analisis statistik yang sesuai. Use $\alpha = 0.02$.

[25 markah]

4. (a) The use of preservatives by food manufacturers has become a controversial issue. Suppose two preservatives (A and B) are extensively tested and determined safe for use in meats. A manufacturer wants to evaluate the preservatives for their effects on retarding spoilage. Six cuts of meat were treated with each preservative and the number of hours until spoilage begins is recorded for each cut of meat

Cut of Meat	Preservative A	Preservative B	Total
1	30	67	97
2	47	83	130
3	26	77	103
4	56	109	165
5	36	94	130
6	43	70	113
Total	238	500	738

$$\sum_i \sum_j Y_{ij}^2 = 52,990$$

- (i) State the appropriate assumptions.
(ii) Test for equal variances if it is needed at $\alpha = 0.02$.
(iii) Perform an appropriate statistical analysis. Use $\alpha = 0.02$.
- (b) One criterion used to evaluate employees in the assembly section of a large factory is the number of defective pieces per 1,000 parts produced. A study was conducted by the quality department to determine if years of experience have an effect on defect rate. Since the job is repetitious after the initial training period, any improvement due to a learning effect might be offset by a decrease in the motivation of a worker. A defect rate is calculated for each worker with different years of experience for a yearly evaluation.

Defect rate	Years of experience			Total
	1	2 - 5	6 - 10	
High	2	3	4	9
Average	10	12	21	43
Low	18	25	15	58
Total	30	40	40	110

$$\sum_i \sum_j Y_{ij}^2 = 1,888$$

Perform an appropriate analysis at the 0.025 level of significance.

[25 marks]

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4. (a) Penggunaan bahan pengawet oleh pengusaha makanan telah menjadi suatu isu kontroversi. Andaikan dua pengawet (A dan B) diuji secara menyeluruh dan ditentukan ianya selamat untuk digunakan untuk daging. Seorang pengusaha ingin menilai keberkesanan pengawet tersebut melambatkan kerosakan. Enam potongan daging dirawat dengan setiap pengawet dan bilangan jam sehingga rosak bermula dicatat bagi setiap potongan daging.

Potongan Daging	Pengawet A	Pengawet B	Jumlah
1	30	67	97
2	47	83	130
3	26	77	103
4	56	109	165
5	36	94	130
6	43	70	113
Jumlah	238	500	738

$$\sum_i \sum_j Y_{ij}^2 = 52,990$$

- (i) Nyatakan anggapan-anggapannya.
(ii) Uji kesamaan varians jika diperlukan pada $\alpha = 0.02$.
(iii) Lakukan suatu analisis statistik yang sesuai. Guna $\alpha = 0.02$.
- (b) Suatu kriteria yang digunakan untuk menilai pekerja di bahagian pemasangan bagi suatu kilang besar adalah bilangan rosak bagi setiap 1,000 unit dihasilkan. Suatu kajian dilakukan oleh jabatan kualiti untuk menentukan sama ada bilangan tahun berpengalaman mempunyai kesan keatas kadar rosak. Oleh kerana tugas tersebut berulang-ulang selepas tempoh awal latihan, sebarang peningkatan disebabkan kesan pembelajaran mungkin di atasi dengan suatu penurunan motivasi seseorang pekerja. Suatu kadar rosak dikira bagi setiap pekerja dengan bilangan tahun pengalaman berbeza untuk setahun penilaian.

Kadar rosak	Bilangan tahun pengalaman			Jumlah
	1	2 - 5	6 -10	
Tinggi	2	3	4	9
Sederhana	10	12	21	43
Rendah	18	25	15	58
Jumlah	30	40	40	110

$$\sum_i \sum_j Y_{ij}^2 = 1,888$$

Lakukan suatu analisis yang sesuai pada paras signifikan 0.025.

[25 markah]

APPENDIX: FORMULAS

1. Z Test

$$Z = \frac{\bar{Y} - \mu}{\sigma/\sqrt{n}}$$

$$Z = \frac{s - \sigma}{\sigma/\sqrt{2n}}$$

$$Z = \frac{\bar{Y}_1 - \bar{Y}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$$Z = \frac{\hat{p}_1 - \hat{p}_2 - (p_1 - p_2)}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$\hat{p} = \frac{Y_1 + Y_2}{n_1 + n_2}$$

2. T Test

$$t = \frac{\bar{Y} - \mu}{s/\sqrt{n}}$$

$$t = \frac{\bar{d} - \mu_d}{s_d/\sqrt{n_d}}$$

$$t = \frac{\bar{Y}_1 - \bar{Y}_2 - (\mu_1 - \mu_2)}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

$$t = \frac{\bar{Y}_1 - \bar{Y}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

3. χ^2 Test

$$\chi^2 = \frac{(n-1)s^2}{\sigma^2}$$

$$\chi^2 = \sum \frac{(O-E)^2}{E}, \quad E = np$$

4. F Test

$$F = \frac{s_1^2}{s_2^2}$$

5. Wilcoxon Signed-Ranks Test

$$T_+ = \frac{n(n+1)}{2} - T_- \quad \text{or} \quad T_- = \frac{n(n+1)}{2} - T_+$$

6. Mann-Whitney Test

$$T = \sum_i R(x_i) - \frac{n_1(n_1+1)}{2}$$