Second Semester Examination
2017/2018 Academic Session

May / June 2018

MAT161 - Elementary Statistics
(Statistik Permulaan)

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **ELEVEN (11)** pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEBELAS (11)** 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 digunapakai].

Question 1

(a) Two hundred and fifty army recruits have the following heights (in centimeter).

Height	165-	170-	174-	180-	183-	190-195
Number of recruits	18	37	60	65	48	22

The tallest 40% of the recruits are to be formed into a special squad. For the members of this squad, estimate:

(i) the minimum height

(ii) the upper quartile height

(b) A candidate attempts a question to which 5 possible answers have been given, one of them is correct. For any question, there is a probability of $\frac{1}{3}$ that he knows the correct answer. If he does not know the correct answer, he will mark one of the answers at random. He does, in fact, mark the correct answer. What is the probability that he knew the correct answer?

(c) Packets of flour packed by a particular machine have masses which are normally distributed with mean 500 gram and standard deviation 20 gram. 2% of the packets are rejected for being underweight and 1% of the packets are rejected for being overweight.

Estimate the mass of a packet of flour if it is to be accepted.

(i) Determine the median mass of the packets of flour that are accepted.

(ii) Six packets of flour are selected at random, what is the probability that at least one is accepted?

[25 marks]

Soalan 1

(a) *Dua ratus lima puluh askar rekrut mempunyai ketinggian berikut (dalam sentimeter).*

Ketinggian	165-	170-	174-	180-	183-	190-195
Bilangan rekrut	*18*	*37*	*60*	*65*	*48*	*22*

40% rekrut yang tertinggi akan dibentuk sebagai skuad khas. Bagi ahli skuad ini, anggarkan:

(i) *ketinggian minimum*

(ii) *ketinggian kuartil atas*

(b) *Seorang calon mencuba satu soalan yang diberikan 5 jawapan yang mungkin, salah satunya betul. Bagi sebarang soalan, kebarangkalian bahawa dia tahu jawapan yang betul adalah* $\frac{1}{3}$*. Jika dia tidak tahu jawapan yang betul, dia akan menandakan satu jawapan secara rawak. Dia sebenarnya, menandakan jawapan yang betul. Apakah kebarangkalian bahawa dia tahu jawapan yang betul?*

(c) *Paket tepung yang dibungkus oleh mesin tertentu mempunyai jisim yang bertaburan normal dengan min 500 gram dan sisihan piawai 20 gram. 2% daripada paket ditolak kerana kurang berat dan 1% daripada paket ditolak kerana berlebihan berat.*

Anggarkan jisim satu paket tepung jika ia diterima.

(i) *Tentukan jisim median paket tepung yang diterima.*

(ii) *Enam paket tepung dipilih secara rawak, apakah kebarangkalian bahawa sekurang-kurangnya satu diterima?*

[25 markah]

Question 2

(a) The number of fire calls in a day at a fire department is recorded for 100 randomly selected days. The data is summarized as below:

Number of calls	0	1	2	3	4	5	6	Total
Number of days	15	20	17	21	9	10	8	100

(i) What is a reasonable probability model for this data?

(ii) Test if this model adequately describes the data. Use $\alpha = 0.01$.

(b) An experiment is designed to study the side effects of two drugs used as treatments for a certain ailment. A group of 180 subjects are randomly assigned to three groups. After the specified drug is given, the side effects are recorded.

Side Effects	Drug A	Drug B	Placebo	Total
None	40	36	30	106
Minor	16	16	24	56
Major	4	8	6	18
Total	60	60	60	180

$$\sum_i \sum_j Y_{ij}^2 = 5{,}000$$

Is there evidence of a difference among the drugs? Test at the 0.10 level of significance.

[25 marks]

Soalan 2

(a) *Bilangan panggilan kebakaran dalam sehari di jabatan bomba dicatat untuk 100 hari yang dipilih secara rawak. Data diringkaskan seperti di bawah:*

Bilangan panggilan	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*Jumlah*
Bilangan hari	*15*	*20*	*17*	*21*	*9*	*10*	*8*	*100*

(i) *Apakah model kebarangkalian yang sesuai bagi data tersebut?*

(ii) *Uji jika model tersebut memerihal data secukupnya. Guna $\alpha = 0.01$.*

(b) *Suatu eksperimen direka untuk mengkaji kesan sampingan dua ubat yang digunakan sebagai rawatan untuk penyakit tertentu. Sekumpulan 180 subjek diumpuk secara rawak kepada tiga kumpulan. Selepas ubat tertentu diberikan, kesan sampingan direkod.*

Kesan Sampingan	*Ubat A*	*Ubat B*	*Placebo*	*Jumlah*
Tiada	*40*	*36*	*30*	*106*
Kecil	*16*	*16*	*24*	*56*
Utama	*4*	*8*	*6*	*18*
Jumlah	*60*	*60*	*60*	*180*

$$\sum_{i}\sum_{j} Y_{ij}^{2} = 5{,}000$$

Adakah terdapat bukti perbezaan antara ubat-ubat tesebut? Uji pada 0.10 aras signfikan.

[25 markah]

Question3

(a) A serious drought related problem for farmers is the spread of aflatoxin, a highly toxic substance caused by mold, which contaminates field corn. In higher levels of contamination, aflatoxin is potentially hazardous to animal and possibly human health. Two sprays, A and B, have been developed to control aflatoxin in field corn, each spray been applied to one field. After three months, seven plots of equal size were randomly selected within each field, and the amount of aflatoxin, in parts per billion, present in the corn was recorded.

Plot	Spray A	Spray B	Total
1	23	13	36
2	30	21	51
3	19	18	37
4	32	18	50
5	29	12	41
6	19	6	25
7	18	12	30
Total	170	100	270

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 5{,}922$$

(i) State the assumptions.
(ii) Perform an appropriate statistical analysis using $\alpha = 0.01$.

(b) In recent years, lack of confidence in the Postal Service has led many companies to send all of their correspondence by private courier. A large company is in the process of selecting one of two possible couriers as its sole delivery method. To help in making the decision, an experiment was performed whereby letters were sent using the couriers to a delivery point across town. The number of minutes required for delivery was recorded per day for each courier.

Day	Courier A	Courier B	Total
1	75	60	135
2	82	82	164
3	74	45	119
4	45	53	98
5	69	51	120
6	71	55	126
7	75	61	136
Total	491	407	898

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 59{,}782$$

(i) State the assumptions.
(ii) Perform an appropriate statistical analysis at the significance level of 0.05.

[25 marks]

Soalan 3

(a) *Masalah kemarau yang serius bagi petani adalah penyebaran aflatoxin, bahan yang sangat toksik yang disebabkan oleh kulat, yang mencemari jagung ladang. Dalam pencemaran yang lebih tinggi, aflatoxin berpotensi bahaya kepada haiwan dan mungkin kesihatan manusia. Dua semburan, A dan B, telah direka untuk mengawal aflatoxin dalam jagung ladang, setiap semburan digunakan pada satu ladang. Selepas tiga bulan, tujuh plot bersaiz sama dipilih secara rawak di dalam setiap ladang, dan jumlah aflatoxin, dalam bahagian per bilion, yang terdapat di dalam jagung dicatat.*

Plot	*Semburan A*	*Semburan B*	*Jumlah*
1	*23*	*13*	*36*
2	*30*	*21*	*51*
3	*19*	*18*	*37*
4	*32*	*18*	*50*
5	*29*	*12*	*41*
6	*19*	*6*	*25*
7	*18*	*12*	*30*
Jumlah	*170*	*100*	*270*

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 5{,}922$$

(i) *Nyatakan suatu anggapan.*
(ii) *Lakukan suatu analisis statistik yang sesuai mengunakan $\alpha = 0.01$.*

(b) *Pada tahun kebelakangan ini, kekurangan keyakinan dalam Perkhidmatan Pos telah menyebabkan banyak syarikat menghantar semua surat kiriman mereka melalui kurier swasta. Sebuah syarikat besar sedang dalam proses memilih salah satu daripada dua kurier yang mungkin sebagai kaedah penghantaran tunggalnya. Untuk membantu membuat keputusan, suatu eksperimen dilakukan yang mana surat dihantar menggunakan kurier ke titik penghantaran di seluruh bandar. Bilangan minit yang diperlukan untuk penghantaran direkodkan setiap hari bagi setiap kurier.*

Hari	*Kurier A*	*Kurier B*	*Jumlah*
1	*75*	*60*	*135*
2	*82*	*82*	*164*
3	*74*	*45*	*119*
4	*45*	*53*	*98*
5	*69*	*51*	*120*
6	*71*	*55*	*126*
7	*75*	*61*	*136*
Jumlah	*491*	*407*	*898*

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 59{,}782$$

(i) *Nyatakan suatu anggapan.*
(ii) *Lakukan suatu analisis statistik yang sesuai pada αras signifikan 0.05.*

[25 markah]

Question 4

(a) A company is planning to market a new cereal with one of two possible package designs: design A, 5-color without cartoons and design B, 3-color with cartoons. To determine which has the most appeal, seven stores are supplied with all two package designs. All packages are priced the same, so that if any design outsells the others, it will be due primarily to visual attractiveness. The cereal is on the market for several months, and the number of sales for each design at each store is recorded.

	Store							
Design	1	2	3	4	5	6	7	Total
A	111	102	120	140	98	110	129	810
B	100	105	114	127	94	111	105	756
Total	211	207	234	267	192	221	234	1,566

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 177{,}402$$

(i) State the assumptions.

(ii) Perform an appropriate statistical analysis at $\alpha = 0.10$.

(b) The manufacturer of Stay-White toothpaste claims that by the addition of a certain chemical he can guarantee that over a given period of time, people will have less dental decay if they clean their teeth regularly with Stay-White, than if they clean their teeth with ordinary toothpaste. To test this theory, free tubes of Stay-White were given to 150 children at a school dental clinic, and at the same time, free tubes of ordinary toothpaste were given to a further 100 children at the clinic. All the children guaranteed to clean their teeth regularly for 6 months and then return for a check-up.
At the end of 6 months, it was found that 32 children using Stay-White had dental decay, whereas 72 children using the ordinary toothpaste had no dental decay.

(i) State the appropriate assumptions.

(ii) Do these data provide enough evidence to support the claim? Use $\alpha = 0.02$.

[25 marks]

Soalan 4

(a) *Sebuah syarikat merancang untuk memasarkan bijirin baru dengan salah satu daripada dua reka bentuk bungkusan yang mungkin: reka bentuk A, 5 warna tanpa kartun dan reka bentuk B, 3-warna dengan kartun. Untuk menentukan yang paling menarik, tujuh kedai dibekalkan dengan kedua-dua reka bentuk bungkusan. Semua bungkusan berharga sama, jika sesuatu reka bentuk mengatasi yang lain, ia akan disebabkan terutamanya oleh daya tarikan visual. Bijirin tersebut di pasarkan selama beberapa bulan, dan jumlah jualan untuk setiap reka bentuk di setiap kedai dicatat.*

	Kedai							
Reka bentuk	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*Jumlah*
A	*111*	*102*	*120*	*140*	*98*	*110*	*129*	*810*
B	*100*	*105*	*114*	*127*	*94*	*111*	*105*	*756*
Jumlah	*211*	*207*	*234*	*267*	*192*	*221*	*234*	*1,566*

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 177{,}402$$

(i) *Nyatakan suatu anggapan.*

(ii) *Lakukan suatu analisis statistik yang sesuai pada $\alpha = 0.10$.*

(b) *Pengilang ubat gigi Stay-White mendakwa bahawa dengan penambahan bahan kimia tertentu dia dapat menjamin bahawa sepanjang tempoh tertentu, orang akan mengalami kurang kerosakan gigi jika mereka membersihkan gigi secara tetap dengan Stay-White, berbanding jika mereka membersihkan gigi mereka dengan ubat gigi biasa. Untuk menguji teori ini, tiub percuma Stay-White diberikan kepada 150 kanak-kanak di klinik pergigian sekolah, dan pada masa yang sama, tiub percuma ubat gigi biasa diberikan kepada 100 kanak-kanak di klinik tersebut. Semua kanak-kanak dijamin membersihkan gigi secara tetap selama 6 bulan dan kemudian kembali untuk pemeriksaan.*
Pada akhir 6 bulan, didapati bahawa 32 kanak-kanak yang menggunakan Stay-White mengalami kerosakan gigi, sementara 72 kanak-kanak yang menggunakan ubat gigi biasa tidak mengalami kerosakan gigi.

(i) *Nyatakan suatu anggapan yang sesuai.*

(ii) *Adakah data memberikan bukti yang cukup untuk menyokong dakwaan tersebut? Guna $\alpha = 0.02$.*

[25 markah]

APPENDIX: FORMULAS

1. Z Test

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

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

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

$$Z = \frac{\left(\hat{p}_1 - \hat{p}_2\right) - \left(p_1 - p_2\right)}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}, \qquad \hat{p} = \frac{Y_1 + Y_2}{n_1 + n_2}$$

2. T Test

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

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

$$t = \frac{\left(\overline{Y}_1 - \overline{Y}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}, \qquad s_p^2 = \frac{\left(n_1 - 1\right)s_1^2 + \left(n_2 - 1\right)s_2^2}{n_1 + n_2 - 2}$$

$$t = \frac{\left(\overline{Y}_1 - \overline{Y}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_1^2}{n_2}}}, \qquad \text{df} = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

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3. χ^2 Test

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

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

4. F Test

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

5. Wicoxon Signed-Rank Test

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

6. Mann-Whitney Test

$$T = \sum_i \mathrm{R}\left(X_i\right) - \frac{n_1\left(n_1+1\right)}{2}$$

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