First Semester Examination
Academic Session 2018/2019

December 2018/January 2019

MAT161- Elementary Statistics
(Statistik Permulaan)

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of TWELVE (12) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi DUA BELAS (12) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions : Answer **FOUR (4)** questions.

*[**Arahan :** Jawab **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) The time taken for a sample of school children to solve a simple problem was recorded.

Time (in seconds)	5-	10-	20-	25-	40-	45-
Frequency	2	12	17	25	2	0

(i) The top 15% will be selected for a competition. Estimate the median time taken for the selected group.

(ii) Samy solve the problem in 23 seconds, find his percentile rank.

(b) Susan takes examination in mathematics, French and psychology. The probability that she passes mathematics is 0.7 and the corresponding probabilities for French and psychology are 0.8 and 0.6.

(i) Find the probability that Susan will fail at least one examination.

(ii) If Susan fails just one examination, find the probability that she fails psychology.

(c) Machine components are mass-produced at a factory. A customer tests the components and finds that 10.75% of those supplied are over-size and 4.95% are under-size. If the lengths of the components are normally distributed with mean 5.2007 centimeter and standard deviation 0.00346 centimeter.

(i) What is the acceptable size of the machine components required by the customer?

(ii) If six of the components are selected at random, what is the probability that at least five of the components meet the acceptable size?

[25 marks]

Soalan 1

(a) *Masa yang diambil suatu sampel murid sekolah untuk menyelesaikan suatu masalah mudah di catat*

Masa (dalam saat)	*5-*	*10-*	*20-*	*25-*	*40-*	*45-*
Kekerapan	*2*	*12*	*17*	*25*	*2*	*0*

(i) *Murid yang 15% teratas akan dipilih untuk suatu pertandingan. Anggarkan median masa yang diambil bagi kumpulan yang dipilih.*

(ii) *Samy menyelesaikan masalah tersebut dalam 23 saat, cari pangkat peperseratusnya.*

(b) *Susan mengambil peperiksaan dalam matematik, bahasa Perancis dan psikologi. Kebarangkalian dia lulus matematik adalah 0.7 dan kebarangkalian yang sepadan bagi bahasa Perancis dan psikologi adalah 0.8 and 0.6.*

(i) *Cari kebarangkalian Susan akan gagal sekurang-kurangnya satu peperiksaan.*

(ii) *Jika Susan gagal hanya satu peperiksaan, cari kebarangkalian dia gagal psikologi.*

(c) *Komponen mesin dihasilkan secara banyak di sebuah kilang. Seorang pelanggan menguji komponen tersebut dan mendapati bahawa 10.75% daripada yang dibekalkan adalah lebih besar dan 4.95% adalah di bawah saiz. Jika panjang komponen bertaburan secara normal dengan min 5.2007 sentimeter dan sisihan piawai 0.00346 sentimeter.*

(i) *Apakah saiz komponen mesin yang diterima yang dikehendaki oleh pelanggan?*

(ii) *Jika enam komponen dipilih secara rawak, apakah kebarangkalian bahawa sekurang-kurangnya lima komponen memenuhi saiz yang diterima?*

[25 markah]

Question 2

(a) A study was conducted to evaluate the effectiveness of a new flu vaccine that had been administered in a small community. The vaccine was provided free of charge in two-shot sequence over a period of two weeks. Some people received the two shot sequence, some appeared for only the first shot, and others received neither. The results of 1000 local residents were then obtained.

	One shot	Two shots	No vaccine	Total
Flu	9	13	24	46
No flu	100	565	289	954
Total	109	578	313	1000

$$\sum_i \sum_j Y_{ij}^2 = 413{,}572$$

Do the data present sufficient evidence to indicate that the vaccine was successful in reducing the number of flu cases in the community? Test at the 0.01 level of significance.

(b) An entomologist was interested in studying the infestation of adult European red mites on apple trees in an orchard. Fifty leaves were randomly selected from each of ten similar apple trees in the orchard and were examined. The number of mites on each of the 500 leaves were recorded.

Number of mites	0	1	2	3	4	5	6	7	Total
Number of leaves	233	127	57	33	30	10	7	3	500

(i) Based on the data, what is a reasonable probability model for the concentration of European mites on apple trees?

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

[25 marks]

Soalan 2

(a) *Suatu kajian telah dilakukan untuk menilai keberkesanan suatu vaksin selesema baru yang diberi dalam suatu komuniti kecil. Vaksin itu diberikan secara percuma dalam urutan dua suntikan selama suatu tempoh dua minggu. Beberapa individu menerima urutan dua suntikan, ada yang datang hanya untuk suntikan pertama, dan yang lain tidak menerima kedua-duanya. Keputusan daripada 1000 penduduk tempatan kemudiannya diperolehi.*

	Satu suntikan	*Dua suntikan*	*Tanpa vaksin*	*Jumlah*
Selesema	*9*	*13*	*24*	*46*
Tiada selesema	*100*	*565*	*289*	*954*
Jumlah	*109*	*578*	*313*	*1000*

$$\sum_i \sum_j Y_{ij}^2 = 413{,}572$$

Adakah data memberikan cukup bukti untuk menunjukkan bahawa vaksin tersebut berjaya dalam mengurangkan kes flu dalam komuniti tersebut? Uji pada aras signifikan 0.01.

(b) *Seorang ahli entomologi berminat untuk mengkaji serangan serangga merah dewasa Eropah ke atas pokok epal di sebuah dusun. Lima puluh helai daun dipilih secara rawak daripada setiap sepuluh pokok epal yang serupa di dusun tersebut dan diperiksa. Bilangan serangga di setiap 500 helai daun dicatatkan.*

Bilangan serangga	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*Jumlah*
Bilangan daun	*233*	*127*	*57*	*33*	*30*	*10*	*7*	*3*	*500*

(i) *Berdasarkan data, apakah model kebarangkalian yang sesuai bagi ketumpuan serangga Eropah atas pokok epal?*

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

[25 markah]

Question 3

(a) In a study to test the effectiveness of a vaccine against a certain disease, 120 experimental animals were given the vaccine and 180 were not. All the animals were then infected with the disease. Among those vaccinated, 15 died as a result of the disease. In the control group, 144 survived.

(i) State the appropriate assumptions.

(ii) Do the data provide enough evidence that the vaccine was effective in reducing the mortality rate? Use $\alpha = 0.10$.

(b) In recent years, consumers have become more safety-conscious, particularly about children's products. A manufacturer of children's pajamas is looking for material that is as nonflammable as possible. In an experiment to test a new fabric with the kind now being used, seven samples of each kind were exposed to an open flame, and the number of seconds until the fabric burst into flames were recorded. As the new material is much more expensive than the current material, the manufacturer will switch only if the new material can be shown to be better. On the basis of the data, what should the manufacturer do?

Sample	Old material	New material	Total
1	15	37	52
2	21	23	44
3	14	13	27
4	27	21	48
5	20	22	42
6	19	13	32
7	22	14	36
Total	143	138	281

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 6{,}193$$

(i) State the assumptions.

(ii) Perform an appropriate statistical analysis at the significance level of 0.20.

[25 marks]

Soalan 3

(a) *Dalam suatu kajian untuk menguji keberkesanan suatu vaksin terhadap suatu penyakit tertentu, 120 haiwan eksperimen diberi vaksin dan 180 tidak. Kesemua haiwan kemudiannya dijangkiti penyakit tersebut. Antara mereka yang divaksin, 15 mati akibat penyakit ini. Dalam kumpulan kawalan, 144 hidup.*

(i) *Nyatakan anggapan yang sepadan.*

(ii) *Adakah data memberi cukup bukti bahawa vaksin tersebut berkesan dalam mengurangkan kadar kematian? Guna* $\alpha = 0.10$.

(b) *Dalam beberapa tahun kebelakangan ini, pengguna telah menjadi lebih mementingkan keselamatan, terutamanya mengenai produk kanak-kanak. Pengusaha baju tidur kanak-kanak sedang mencari kain yang tidak mudah terbakar. Dalam suatu eksperimen untuk menguji kain baru dengan jenis yang sedang digunakan, tujuh sampel daripada setiap jenis didedahkan kepada api, dan bilangan saat sehingga terdapat nyalaan api pada kain dicatat. Oleh kerana kain baru jauh lebih mahal daripada kain semasa, pengusaha akan beralih hanya jika kain baru dapat ditunjukkan lebih baik. Berdasarkan data, apa yang harus pengusaha lakukan?*

Sampel	*Kain lama*	*Kain baru*	*Jumlah*
1	*15*	*37*	*52*
2	*21*	*23*	*44*
3	*14*	*13*	*27*
4	*27*	*21*	*48*
5	*20*	*22*	*42*
6	*19*	*13*	*32*
7	*22*	*14*	*36*
Jumlah	*143*	*138*	*281*

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 6{,}193$$

(i) *Nyatakan suatu anggapan.*

(ii) *Lakukan suatu analisis statistik yang sesuai pada aras signifikan 0.20.*

[25 markah]

Question 4

(a) A supermarket conducted an experiment to investigate customer response to the use of background music. In the experiment, eight stores were randomly assigned to different types of background music: type A, soft and slow contemporary; and type B, medium-volume, slow contemporary. After the background music was used for one week, 100 customers were randomly selected and questioned to determine whether they liked the background music. The percentages that liked the music and favored its continued use are recorded.

	Store								
Music	1	2	3	4	5	6	7	8	Total
Type A	93	96	80	94	67	80	94	56	660
Type B	75	68	87	80	81	44	96	80	611
Total	168	164	167	174	148	124	190	136	1,271

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 104{,}293$$

(i) State the assumptions.

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

(b) A power plant which uses water from the surrounding bay for cooling its condensers, is required by the Environmental Agency to determine whether discharging its heated water into the bay has a detrimental effect on the flora (plant life) in the water. The agency requires that the power plant make its investigations at two strategically locations. Location A is located near the plant's discharge tubes and location B is located farther out in the bay. During one randomly selected day in each of eight months, a diver descends to each of the locations, randomly samples a square meter area of the bottom and counts the number of blades of the different types of grasses present. The results for one important grass type is recorded.

	Month								
Location	March	April	May	June	July	August	September	October	Total
A	28	25	37	20	31	22	30	26	219
B	53	61	56	48	57	65	60	52	452
Total	81	86	93	68	88	87	90	78	671

$$\sum_{i=1}\sum_{j=1} Y_{ij}^2 = 31{,}947$$

(i) State the assumptions.

(ii) Perform an appropriate statistical analysis at the significance level of 0.01.

[25 marks]

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Soalan 4

(a) *Suatu pasaraya mengadakan eksperimen untuk mengkaji sambutan pelanggan terhadap penggunaan muzik latar belakang. Dalam eksperimen tersebut, lapan kedai diumpukkan secara rawak kepada pelbagai jenis muzik latar belakang: jenis A, kontemporari lembut dan perlahan; dan jenis B, kelantangan sederhana, kontemporari perlahan. Setelah muzik latar belakang digunakan selama seminggu, 100 pelanggan dipilih secara rawak dan ditanyai untuk menentukan sama ada mereka gemar muzik latar belakang tersebut. Peratusan yang menggemari muzik tersebut dan menyokong penggunaannya berterusan direkodkan.*

	Kedai								
Muzik	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Jumlah*
Jenis A	*93*	*96*	*80*	*94*	*67*	*80*	*94*	*56*	*660*
Jenis B	*75*	*68*	*87*	*80*	*81*	*44*	*96*	*80*	*611*
Jumlah	*168*	*164*	*167*	*174*	*148*	*124*	*190*	*136*	*1,271*

$$\sum_{i=1}\sum_{j=1} Y_{ij}^{2} = 104{,}293$$

(i) *Nyatakan suatu anggapan.*

(ii) *Lakukan suatu analisis statistik yang sesuai pada aras signifikan 0.05.*

(b) *Suatu loji janakuasa yang menggunakan air daripada teluk di sekitar untuk menyejukkan kondensornya, diperlukan oleh Agensi Alam Sekitar untuk menentukan sama ada melepaskan air yang panas ke dalam teluk itu mempunyai kesan buruk terhadap flora (kehidupan tumbuhan) di dalam air. Agensi itu menghendaki loji janakuasa itu membuat siasatannya di dua lokasi strategik. Lokasi A terletak berhampiran tiub pelepasan kilang dan lokasi B terletak lebih jauh di teluk. Semasa satu hari yang dipilih secara rawak dalam setiap lapan bulan, seorang penyelam turun ke setiap lokasi, secara rawak memilih sampel kawasan satu meter persegi di dasar laut dan mengira bilangan daun bagi pelbagai jenis rumput yang wujud. Keputusan untuk satu jenis rumput penting dicatat.*

				Bulan					
Lokasi	*Mac*	*April*	*Mei*	*Jun*	*Julai*	*Ogos*	*September*	*October*	*Jumlah*
A	*28*	*25*	*37*	*20*	*31*	*22*	*30*	*26*	*219*
B	*53*	*61*	*56*	*48*	*57*	*65*	*60*	*52*	*452*
Jumlah	*81*	*86*	*93*	*68*	*88*	*87*	*90*	*78*	*671*

$$\sum_{i=1}\sum_{j=1} Y_{ij}^{2} = 31{,}947$$

(i) *Nyatakan suatu anggapan.*

(ii) *Lakukan suatu analisis statistik yang sesuai pada aras signifikan 0.01.*

[25 markah]

APPENDIX: FORMULAS

1. Z Test

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

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

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

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

2. T Test

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

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

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

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

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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