UNIVERSITI SAINS MALAYSIA

First Semester Examination
2013/2014 Academic Session

December 2013 / January 2013

MAT 161 - Elementary Statistics
[Statistik Permulaan]

Duration : 3 hours
[Masa : 3 jam]

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

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH 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) The weight (in grams) of mangoes obtained from a fruit farm were recorded.

Weight	Less than 70	70-	80-	90-	95-
Frequency	0	4	11	10	16

Weight	100-	105-	110-	120-	130 and over
Frequency	22	15	8	4	0

Mangoes of certain weights will be sold in farmers' markets. 10% of the mangoes are considered small and 20% of the large mangoes are to be sold in hypermarkets.

(i) What would be the weights of mangoes that are sent to farmers' markets?

(ii) Obtain the median weight of mangoes sold to farmers' market.

(iii) If a mango was randomly selected and the weight is 103 grams, obtain its percentile rank. Would that mango be accepted to the farmers' market?

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

(i) Find the probability that Susan fails in at least two examinations

(ii) Given that Susan fails just one examination, find the probability that she fails history.

(c) In a food processing and packaging plant, machine breakdowns have been occurring at the rate of 4 every month.

(i) In five months selected at random, what is the probability that at least two months there are no more than 4 machine breakdowns.

(ii) Find the probability that there will be at least 40 breakdowns during one year.

[25 marks]

1. (a) Berat (dalam gram) bagi buah manga yang diperolehi daripada suatu ladang buah-buahan dicatat.

Berat	*Kurang daripada 70*	*70-*	*80-*	*90-*	*95-*
Kekerapan	*0*	*4*	*11*	*10*	*16*

Berat	*100-*	*105-*	*110-*	*120-*	*130 dan lebih*
Kekerapan	*22*	*15*	*8*	*4*	*0*

Mangga yang berberat tertentu akan dijual di pasar tani. 10% daripada buah manga tersebut adalah kecil dan 20% daripada mangga besar dijual di pasaraya.

(i) Berapakah berat mangga yang dihantar ke pasar tani?

(ii) Dapatkan berat median buah mangga yang dijual di pasar tani.

(iii) Jika sebuah mangga dipilih secara rawak dan beratnya adalah 103 gram, dapatkan pangkat persentilnya. Bolehkah buah mangga tersebut di terima di pasar tani?

(b) Susan menduduki peperiksaan dalam matematik, bahasa Perancis dan sejarah. Kebarangkalian dia lulus matematik adalah 0.7dan kebarangkalian sepadan bagi bahasa Perancis dan sejarah adalah 0.8 dan 0.6

(i) Cari kebarangkalian bahawa Susan gagal sekurang-kurangnya pada dua peperiksaan.

(ii) Jika Susan gagal hanya satu peperiksaan, cari kebarangkalaian bahawa dia gagal sejarah.

(c) Bagi suatu kilang pemprosesan dan pembungkusan makanan, kerosakan mesin berlaku pada kadar 4 sebulan.

(i) Dalam lima bulan yang dipilih secara rawak, apakah kebarangkalian bahawa sekurangnya pada dua bulan tidak lebih daripada 4 mesin rosak.

(ii) Cari kebarangkalian bahawa sekurangnya 40 mesin rosak dalam tempoh setahun.

[25 markah]

2. (a) Tests for defects were carried out in a textile factory on a lot comprising 400 pieces of cloth. The results of the tests are recorded in a table.

Number of faults per piece	0	1	2	3	4	5	6
Number of pieces	92	142	96	46	18	6	0

What probability model adequately describes this data? Test at $\alpha = 0.05$.

(b) Two different techniques are to be investigated for teaching elementary calculus.

Technique I: computer-assisted instruction in conjunction with lectures
Technique II: computer-assisted instruction only

A random sample of 200 students were randomly assigned to each of the three teaching techniques and the final grades of the students were recorded.

Technique	A	B	C	D	Total
I	15	34	40	11	100
II	11	26	34	29	100
Total	26	60	74	40	200

$$\sum_i \sum_j Y_{ij}^2 = 5{,}896$$

(i) State the assumptions.

(ii) Perform an appropriate statistical analysis to determine which technique is effective.
Test at the 0.05 level of significance

(c) The sugar content of a fruit after being picked was recorded daily for a period of eight days.

Day	0	1	2	3	4	5	6	7	8
Sugar	7.9	12.0	9.5	10.8	11.3	11.8	11.3	4.2	0.4

Determine whether a change in the sugar content has occurred as the day progresses. Use $\alpha = 0.10$

[25 marks]

2. *(a) Tests for defects were carried out in a textile factory on a lot comprising 400 pieces of cloth. The results of the tests are recorded in a table.*

Bilangan rosak sehelai	*0*	*1*	*2*	*3*	*4*	*5*	*6*
Bilangan helaian	*92*	*142*	*96*	*46*	*18*	*6*	*0*

Apakah model kebarangkalian yang memberihal data ini secukupnya? Uji pada α = 0.05.

(b) Dua teknik dikaji untuk pengajaran kalkulus permulaan.

Teknik I: pengajaran berbantu-komputer bersama dengan kuliah
Teknik II: pengajaran berbantu-komputer sahaja

Suatu sampel rawak 200 orang pelajar diumpukkan secara rawak kepada setiap satu teknik pengajaran dan gred akhir pelajar dicatat.

Tecknik	*A*	*B*	*C*	*D*	*Jumlah*
I	*15*	*34*	*40*	*11*	*100*
II	*11*	*26*	*34*	*29*	*100*
Jumlah	*26*	*60*	*74*	*40*	*200*

$\sum_i \sum_j Y_{ij}^2 = 5{,}896$

(i) Nyatakan anggapan-anggapannya.
(ii) Lakukan suatu analisis statistik yang sesuai untuk menentukan teknik yang berkesan. Uji pada aras signifikan 0.05.

(c) Kandungan gula bagi sejenis buah selepas dipetik dicatat setiap hari untuk selama lapan hari.

Day	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sugar	*7.9*	*12.0*	*9.5*	*10.8*	*11.3*	*11.8*	*11.3*	*4.2*	*0.4*

Tentukan sama ada berlaku perubahan dalam kandungan gula dengan berlalunya hari. Guna α *= 0.10*

[25 markah]

3. (a) An educational psychologist claims that the order in which test questions are asked affects a student's ability to answer correctly. To investigate this assertion, a professor prepares one set of test questions but arranges the question in two different orders. On test A the questions are arranged in order of increasing difficulty (that is from the easiest to most difficult), while on test B the order is reversed. Seven students were randomly selected and assigned to each test. The test score is recorded for each student.

	Student							
Test	1	2	3	4	5	6	7	Total
A	90	71	83	82	75	91	55	547
B	66	78	42	68	80	60	70	464
Total	156	149	125	150	155	151	125	1,011

$$\sum_i \sum_j Y_{ij}^2 = 75{,}413$$

(i) State the assumptions.
(ii) Test for equal variances if it is needed at $\alpha = 0.10$.
(iii) Perform an appropriate statistical analysis.

(b) A business firm wishes to evaluate the performance of photocopier A and B. Copier A costs more than copier B. The makers of copier A argue that the percentage of acceptable produced by their machines exceeds that of their competitor. If this can be substantiated statistically, then machine A will be more economical in the long run and will be purchased, otherwise machine B will be purchased. Tests of the two machines yield the following data:

	Machine A	Machine B
Number of copies run	1000	900
Number of unacceptable copies	100	105

(i) State the assumptions.
(ii) Do these data support the contention of the makers of copier A? Use $\alpha = 0.01$.

[25 marks]

3. (a) *Seorang ahli psikologi pendidikan mendakwa bahawa susunan soalan ujian memberi kesan kepada kemampuan seseoarang pelajar untuk menjawab dengan betul. Untuk mengkaji sangkaan ini, seorang professor menyediakan satu set soalan ujian tetapi menyusun soalan tersebut dalam dua susunan berlainan. Bagi ujian A soalan disusun mengikut peringkat kepayahan (iaitu daripada yang paling mudah ke yang paling susah), manakala bagi ujian B susunannya adalah terbalik. Tujuh orang pelajar dipilih secara rawak dan diumpukkan kepada setiap ujian. Skor ujian dicatat untuk setiap pelajar.*

	Pelajar							
Ujian	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*Jumlah*
A	*90*	*71*	*83*	*82*	*75*	*91*	*55*	*547*
B	*66*	*78*	*42*	*68*	*80*	*60*	*70*	*464*
Jumlah	*156*	*149*	*125*	*150*	*155*	*151*	*125*	*1,011*

$$\sum_i \sum_j Y_{ij}^2 = 75{,}413$$

(i) Nyatakan anggapan-anggapannya.

(ii) Uji kesamaan varians jika diperlukan pada $\alpha = .10$.

(iii) Lakukan suatu analisis statistik yang sesuai.

(b) *Suatu firma perniagaan ingin menilai prestasi alat fotokopi A and B. Mesin A adalah lebih mahal daripada mesin B. Pembuat mesin A mendakwa bahawa peratusan yang diterima yang dihasilkan oleh mesin mereka melebihi daripada pesaing. Jika perkara ini dapat dibuktikan secara statistik, maka mesin A adalah lebih jimat dalam jangkamasa panjang dan ia akan dibeli, tetapi jika sebaliknya mesin B akan dibeli. Ujian keatas alat ini menghasilkan data berikut:*

	Mesin A	*Mesin B*
Bilangan salinan	*1000*	*900*
Bilanmgan salinan yang tak diterima	*100*	*105*

(i) Nyatakan anggapan-anggapannya.

(ii) Adakah data menyokong dakwaan pembuat alat fotokopi A? Guna $\alpha = 0.01$.

[25 markah]

4. (a) Psychologists have studied the effect of the working environment or surroundings on the quality and quantity of work done. Many businesses have music piped into the work area to improve the environment. An experiment is performed to determine which type of music, classical or country is best suited for a particular company. The types of music are tried, each on six workdays. The productivity is measured by recording the number of items produced on each of the days

	Type of Music		
Day	Country	Classical	Total
1	857	824	1681
2	801	847	1648
3	795	881	1676
4	842	865	1707
5	835	836	1671
6	827	852	1679
Total	4,957	5,105	10,062

$\sum_i \sum_j Y_{ij}^2 = 8{,}443{,}764$

(i) State the assumptions.
(ii) Test for equal variances if it is needed at $\alpha = .01$.
(iii) Perform an appropriate statistical analysis.

(b) A power plant which uses water from the surrounding bay for cooling its condensers is required by the environment protection agency (EPA) to determine whether discharging its heated water into the bay has a detrimental effect on the flora (plant life) in the water. The EPA requests that the power plant makes its investigation at two strategically chosen locations. Location A are located near the plant's discharge tubes while location B is located farther out in the bay. During one randomly selected day in each of six 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.

	Month						
Location	March	April	May	June	July	August	Total
1	31	22	30	26	32	30	321
2	53	64	56	48	51	49	171
Total	84	86	86	74	83	79	492

$\sum_i \sum_j Y_{ij}^2 = 22{,}292$

(i) State the assumptions.
(ii) Test for equal variances if it is needed at $\alpha = 0.05$.
(iii) Perform an appropriate statistical analysis.

[25 marks]

4. (a) *Ahli psikologi telah mengkaji keberkesanan suasana atau keadaan sekeliling keatas kualiti dan kuantiti kerja yang dilakukan. Banyak perniagaan menyalurkan muzik ke ruang kawasan bekerja untuk meningkatkan suasana. Suatu ujikaji dilakukan untuk menentukan jenis muzik, klasik atau 'country', yang paling sesuai untuk sebuah syarikat tertentu. Jenis muzik tersebut dicuba, setiap pada enam hari bekerja. Produktiviti diukur dengan mencatat bilangan item yang dihasilkan pada setiap hari tersebut.*

	Jenis Muzik		
Hari	*'Country'*	*Klasik*	*Jumlah*
1	*857*	*824*	*1681*
2	*801*	*847*	*1648*
3	*795*	*881*	*1676*
4	*842*	*865*	*1707*
5	*835*	*836*	*1671*
6	*827*	*852*	*1679*
Jumlah	*4,957*	*5,105*	*10,062*

$\sum_i \sum_j Y_{ij}^2 = 8{,}443{,}764$

(i) Nyatakan anggapan-anggapannya.
(ii) Uji kesamaan varians jika diperlukan pada $\alpha = .01$.
(iii) Lakukan suatu analisis statistik yang sesuai.

(b) *Suatu loji kuasa yang menggunakan air daripada teluk sekitarnya untuk menyejukkan kondensernya dikehendaki oleh agensi perlindungan persekitaran (EPA) untuk menentukan sama ada melepaskan air panasnya ke dalam teluk memberi kesan mudarat keatas flora (kehidupan tumbuhan) dalam air. Pihak EPA mengarahkan loji kuasa tersebut membuat penyelidikan pada dua lokasi yang dipilih secara strategik. Lokasi A berdekatan dengan pelepasan loji manakala lokasi B jauh keluar tetapi masih dalam kawasan teluk. Pada satu hari yang dipilih secara rawak dalam setiap enam bulan, seorang penyelam meyelam ke setiap lokasi, mengambil secara rawak sampel satu meter persegi bahagian bawah, dan mengira bilangan dedaun bagi berlainan jenis rumpai yang ada.*

			Bulan				
Lokasi	*Mac*	*April*	*Mei*	*Jun*	*Julai*	*Ogos*	*Jumlah*
A	*31*	*22*	*30*	*26*	*32*	*30*	*321*
B	*53*	*64*	*56*	*48*	*51*	*49*	*171*
Jumlah	*84*	*86*	*86*	*74*	*83*	*79*	*492*

$\sum_i \sum_j Y_{ij}^2 = 22{,}292$

(i) Nyatakan anggapan-anggapannya.
(ii) Uji kesamaan varians jika diperlukan pada $\alpha = .05$.
(iii) Lakukan suatu analisis statistik yang sesuai.

[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

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

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

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

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

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3. χ^2 **Test**

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

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

4. F Test

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

5. Wicoxon Signed-Ranks Test

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

6. Mann-Whitney Test

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

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