

THE HONG KONG POLYTECHNIC UNIVERSITY

Department of Applied Mathematics

Examination

Subject Code: AMA1501/AMA1502 Subject Title: Introduction to Statistics for
Business / Introduction to
Statistics

Session: Semester 1, 2016/2017

Date: 10 December 2016 Time: 3:15 p.m. – 6:15 p.m.

Time Allowed: 3 Hours

This question paper has 13 pages (attachments included).

Instructions to Candidates: This question paper has SIX questions.
Attempt FIVE questions.
All questions carry equal marks.

Attachments: Standard Normal Distribution Table, t -distribution Table,
 χ^2 -distribution Table, F-distribution Table, Formula Sheets

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DO NOT TURN OVER THE PAGE UNTIL YOU ARE TOLD TO DO SO

1. The analyst of an insurance company investigates this year's amount of expenses per invoice submitted by their customers after consulting medical specialists. The amount of expenses (corrected to the nearest dollars) of a random sample of invoices are summarized below:

Amount of expenses (\$)	Number of invoices
201 – 400	4
401 – 500	9
501 – 600	15
601 – 700	28
701 – 800	56
801 – 900	32
901 – 1000	6

- (a) Calculate the mean and standard deviation of amount of expenses per invoice. (6 marks)
- (b) Estimate, from the frequency distribution table, the minimum amount of the highest 10% expenses. (4 marks)
- (c) Estimate, from the frequency distribution table, the proportion of invoices having amount of expenses between \$680 and \$920. (4 marks)
- (d) In a random sample of 100 invoices received last year, thirty of them have amount of expenses between \$680 and \$920. Test whether the proportion of invoices having amount of expenses between \$680 and \$920 this year is higher than that of last year at 5% level of significance. (6 marks)
2. (a) There are projects to be assigned to six students at random so that each student gets one. Among the projects to be assigned, three are related to Accounting, four are related to Economics and five are related to Marketing. Calculate the number of ways of assigning the projects such that two projects of each discipline are assigned. (4 marks)
- (b) The international office of a college studies the students' preferred continents for study tour to be organized in the coming summer vacation. The results showing that 55% prefer Western European countries, 80% prefer North American countries, and 5% prefer neither Western European countries nor North American countries
- (i) Calculate the probability of a randomly selected student prefers Western European countries or North American countries. (3 marks)
- (ii) Given that a randomly selected student prefers North American countries, calculate the probability that he/she prefers Western European countries. (3 marks)
- (iii) Given that a randomly selected student does not prefer Western European countries, calculate the probability that he/she prefers North American countries. (4 marks)

(Question 2 Cont'd)

- (c) A company organizes a training course to improve the leadership skills of its employees. Participants are required to evaluate the usefulness of the training course after completion. The percentages of participants coming from HR Department, Marketing Department, R&D Department and other departments are 15%, 30%, 35% and 20%, respectively; and their corresponding percentages rating 'the course is useful' are 75%, 70%, 80% and 85%, respectively. Five participants of the course are selected randomly from a randomly chosen department, and two of them rate 'the course is useful'. What is the probability that the five participants came from R&D Department? (6 marks)
3. (a) The scores of a generic competence test in the latest recruitment exercise of a company follow the normal distribution approximately with a mean of 78 and a standard deviation of 8.
- (i) Calculate the probability that a randomly selected candidate has a score between 72 and 92. (3 marks)
- (ii) If ten candidates are randomly selected, find the probability that more than 3 of them have a score between 72 and 92. (5 marks)
- (iii) If the score of the generic competence test is above 75, the candidate will be invited to an interview. Calculate the probability that at least three quarters of two hundred randomly selected candidates will be invited to the interview. (5 marks)
- (b) The number of vehicles arriving at a maintenance depot follows the Poisson distribution with a mean of eight per hour.
- (i) Calculate the probability that during a thirty-minute period, more than five vehicles arriving at the maintenance depot. (4 marks)
- (ii) If there are more than five vehicles arriving at the maintenance depot in a thirty-minute period, then six technical staff will provide maintenance service; otherwise four technical staff will provide service. Calculate the mean number of technical staff that will provide maintenance service in the coming thirty-minute period. (3 marks)
4. (a) The monthly rate of return of a company follows the normal distribution approximately with a mean of 12% and a standard deviation of 5%. Calculate the probability that the average monthly rate of return of four randomly selected months exceeds 10%. (4 marks)
- (b) The production manager studies the assembly time of a product by trainees. A random sample of trainees is selected and the assembly times (in minutes) are listed below.
- | | | | |
|------|------|------|------|
| 12.8 | 13.2 | 11.5 | 12.2 |
| 14.1 | 10.9 | 12.4 | 11.6 |

Construct a 95% confidence interval for the population mean assembly time of a product by trainees. Assume that the assembly times are normally distributed.

(5 marks)

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(Question 4 Cont'd)

- (c) The marketing manager of a chain store studies the purchasing behaviour of his VIP customers. Among four hundred randomly selected VIP customers, eighty-four of them spent more than \$20,000 during annual mega sales. Test whether the population proportion of VIP customers who spent more than \$20,000 during annual mega sales is less than 23% at 1% level of significance. (5 marks)
- (d) The CEO of a chain shop compares the weekly sales revenue of branches which are located at urban area and rural area. Independent random samples of shops having approximately the same floor area are drawn with statistics provided below.

	Sample size	Mean	Standard deviation
Urban area	10	\$280000	\$12000
Rural area	8	\$200000	\$11000

Can we conclude that the mean weekly sales revenue of branches located at rural area is lower than that of urban area at 5% level of significance? Assume that the populations of weekly sales revenue are normally distributed with equal variances. (6 marks)

5. (a) Senior project manager of a company compares the project duration estimated by two project managers. A random sample of projects is selected and the estimated project durations (in weeks) are listed in the following table.

Project	1	2	3	4	5	6	7
Manager A	22	18	33	10	30	28	24
Manager B	24	17	36	9	33	31	23

Is there any difference between the mean project duration estimated by two project managers at 5% level of significance? State your assumptions. (7 marks)

- (b) A customer services manager has extracted from the computer system regarding the number of telephone enquiries received in 200 randomly selected 5-minute periods.

Number of telephone enquiries	0	1	2	3	4	5
Number of time periods	23	35	62	48	24	8

Can the customer services manager conclude that the number of telephone enquiries received in 5-minute period follow the uniform distribution at 5% level of significance? (6 marks)

- (c) The employees' level of satisfaction on medical benefits and the staff banding of a random sample of employees are tabulated in the following two-way contingency table:

Staff Banding	Level of satisfaction		
	Unsatisfactory	Neutral	Satisfactory
Senior Management	33	58	29
Middle Management	22	46	72
Subordinate	15	36	39

Test whether employees' level of satisfaction on medical benefits and staff banding are independent at 1% level of significance. (7 marks)

6. (a) A production manager conducted an experiment in the last twelve days, in order to study the relationship between the relative humidity in a storage place (x , in %) and the moisture content of raw materials (y , in %). Summaries of the daily data are given below:

$$\sum x = 533, \sum x^2 = 24529, \sum y = 132, \sum y^2 = 1526 \text{ and } \sum xy = 6093$$

- (i) Find the least squares linear regression equation for predicting moisture content of raw materials using relative humidity in the storage place. (4 marks)
- (ii) Predict the moisture content of raw materials when the relative humidity in the storage place is 58%. (2 marks)
- (iii) What is the percentage of variation in the moisture content of raw materials which cannot be explained by the fitted model in (i)? (2 marks)
- (b) The government of a metropolitan city wishes to predict suicide rate from five independent variables by constructing a multiple regression model. The five independent variables are unemployment rate (x_1), percentage of females in the labour force (x_2), divorce rate (x_3), logarithm of GNP (x_4) and annual change in GNP (x_5). A random sample of size 46 is used and some of the results provided by a statistical software are shown in the following table. In addition, the coefficient of determination of the model is 0.45.

	<i>Coefficients</i>	<i>p-value</i>
Intercept	0.002	
x_1	0.0204	0.002
x_2	-0.0231	0.02
x_3	0.0765	> 0.10
x_4	0.2760	> 0.10
x_5	0.0018	> 0.10

- (i) Write down the fitted multiple linear regression equation. (2 marks)
- (ii) Interpret the coefficient estimate of x_2 . (2 marks)
- (iii) Test the significance of the overall model at 5% level of significance. (4 marks)
- (iv) List the significant independent variables at 10% level of significance with justification. (4 marks)

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