First Semester Examination
Academic Session 2018/2019

December 2018/January 2019

MSG352 - Linear and Integer Programming
(Pengaturcaraan Linear dan Integer)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of FIVE (5) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMA (5) 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 diguna pakai].

Question 1

(a) Suppose that a Linear Program (LP) was solved using the Simplex Method and also the Revised Simplex Method. Would the optimal solution be the same? Why, or why not?

[3 marks]

(b) Explain the **main advantage** that the Revised Simplex Method has over the Simplex Method.

[2 marks]

(c) Write a **paragraph of text** that briefly discusses the **main idea** behind the cutting planes method for solving pure Integer Programs.

[5 marks]

(d) Consider the following LP:

$$\text{maximise} \quad z = 2x_1 + 2x_2 + x_3 - 3x_4$$

subject to

$$\begin{aligned} 3x_1 + x_2 - x_4 &\leq 1 \\ x_1 + x_2 + x_3 + x_4 &\leq 2 \\ -3x_1 + 2x_3 + 5x_4 &\leq 6 \\ x_1, \quad x_2, \quad x_3, \quad x_4 &\geq 0. \end{aligned}$$

(i) Given that $\mathbf{x}^*_{BV} = \{x_3, x_2, s_3\}$, obtain the optimal tableau.

(ii) Obtain the new optimal solution when the following constraint is added to the LP:

$$x_1 + 2x_2 + 2x_3 \leq 3.$$

[20 marks]

Soalan 1

(a) Andaikan suatu masalah Pengaturcaraan Linear (PL) diselesaikan dengan menggunakan Kaedah Simpleks dan juga Kaedah Simpleks Tertilik Semula. Adakah penyelesaian optimum bagi kedua-duanya sama? Mengapa, atau mengapa tidak?

[3 markah]

*(b) Jelaskan **kelebihan utama** yang terdapat pada Kaedah Simpleks Tertilik Semula berbanding Kaedah Simpleks.*

[2 markah]

*(c) Karangkan **sebuah petikan** yang membincangkan secara ringkas **idea utama** di belakang Kaedah Potongan Satah bagi menyelesaikan masalah Pengaturcaraan Integer tulen.*

[5 markah]

(d) Pertimbangkan masalah PL berikut:

$$\textit{maksimumkan} \quad z = 2x_1 + 2x_2 + x_3 - 3x_4$$

terhadap

$$\begin{aligned} 3x_1 + x_2 - x_4 &\leq 1 \\ x_1 + x_2 + x_3 + x_4 &\leq 2 \\ -3x_1 + 2x_3 + 5x_4 &\leq 6 \\ x_1, \quad x_2, \quad x_3, \quad x_4 &\geq 0. \end{aligned}$$

(i) Diberi $\mathbf{x}^*_{BV} = \{x_3, x_2, s_3\}$, dapatkan tablo optimum.

(ii) Dapatkan penyelesaian optimum baru jika kekangan berikut dimasukkan ke dalam masalah PL:

$$x_1 + 2x_2 + 2x_3 \leq 3.$$

[20 markah]

Question 2

Solve the following:

$$\text{minimise} \quad z = 14x_1 + 16x_2 + 15x_3$$

subject to

$$\begin{aligned} x_1 + x_2 &\geq 1 \\ x_2 + x_3 &\geq 1 \\ x_1 + x_3 &\geq 1 \\ x_1, \quad x_2, \quad x_3 &\in \{0,1\}. \end{aligned}$$

[20 marks]

Soalan 2

Selesaikan masalah berikut:

$$\textit{minimumkan} \quad z = 14x_1 + 16x_2 + 15x_3$$

terhadap

$$\begin{aligned} x_1 + x_2 &\geq 1 \\ x_2 + x_3 &\geq 1 \\ x_1 + x_3 &\geq 1 \\ x_1, \quad x_2, \quad x_3 &\in \{0,1\}. \end{aligned}$$

[20 markah]

Question 3

Consider the following Linear Program (LP):

$$\begin{aligned} &\text{maximise} && z = 3x_1 + x_2 \\ &\text{subject to} \\ & && -x_1 + x_2 \leq 1 \\ & && x_1 \geq 3 \\ & && x_1, \quad x_2 \geq 0. \end{aligned}$$

(a) Obtain the dual LP and solve the dual LP by inspection.

[7 marks]

(b) Based on your answer in (a), predict the type of solution for the primal LP. Justify your answer without solving the primal LP.

[3 marks]

(c) Use the Revised Simplex Method to solve the primal LP and state how the solution relates to your answer in (b).

[15 marks]

Soalan 3

Pertimbangkan masalah Pengaturcaraan Linear (PL) berikut:

$$\begin{aligned} &\textit{maksimumkan} && z = 3x_1 + x_2 \\ &\textit{terhadap} \\ & && -x_1 + x_2 \leq 1 \\ & && x_1 \geq 3 \\ & && x_1, \quad x_2 \geq 0. \end{aligned}$$

(a) Dapatkan masalah PL dual dan selesaikan masalah PL dual menggunakan kaedah pemeriksaan.

[7 markah]

(b) Berdasarkan jawapan anda di (a), ramalkan jenis penyelesaian bagi masalah PL primal. Berikan justifikasi bagi jawapan anda tanpa menyelesaikan masalah PL primal.

[3 markah]

(c) Gunakan Kaedah Simpleks Tertilik Semula untuk menyelesaikan masalah PL primal dan nyatakan bagaimana penyelesaian berkait dengan jawapan anda di (b).

[15 markah]

Question 4

Gorilla Marketing Sdn. Bhd. has been hired to carry out a survey for a new product. They must assign interviewers to conduct interviews via telephone and in person. One interviewer can handle 80 phone interviews or 40 personal interviews in a day. Interviewers are only allowed to conduct one type of interview per day. It costs RM50 per day for a telephone interviewer, and RM70 per day for a personal interviewer. Gorilla Marketing's client has set the following goals (in order of most to least important):

- At least 3000 daily interviews are conducted in total.
- The daily budget is RM2500.
- At least 1000 interviews are done by telephone daily.

Formulate and solve a preemptive Goal Programming problem for Gorilla Marketing Sdn. Bhd.

[25 marks]

Soalan 4

Gorilla Marketing Sdn. Bhd. telah diminta untuk menjalankan tinjauan bagi suatu produk baru. Mereka mesti melantik pekerja untuk mengadakan temuduga melalui telefon dan secara peribadi. Satu penemuduga boleh mengendalikan 80 temuduga melalui telefon atau 40 temuduga secara peribadi dalam satu hari. Penemuduga hanya dibenarkan melakukan satu jenis temuduga setiap hari. Kos sebanyak RM50 sehari diperlukan untuk seorang penemuduga melalui telefon dan sebanyak RM70 sehari untuk seorang penemuduga secara peribadi. Pelanggan Gorilla Marketing telah menetapkan gol berikut (daripada paling penting kepada paling tidak penting):

- *Sekurang-kurangnya 3000 temuduga dikendalikan setiap hari.*
- *Bajet setiap hari adalah RM2500.*
- *Sekurang-kurangnya 1000 temuduga dilakukan melalui telefon setiap hari.*

Rumuskan dan selesaikan suatu masalah Pengaturcaraan Gol "preemptive" untuk Gorilla Marketing Sdn. Bhd.

[25 markah]

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