UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2016/2017 Academic Session

June 2017

MGM551 - Operations Research
[Penyelidikan Operasi]

Duration : 3 hours
[Masa : 3 jam]

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

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LAPAN 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].

Question 1

(a) Urban Tech Sdn. Bhd. has 2 designers available to work on their next 3 projects. Each designer has a maximum of 80 hours to split between the projects. The following table shows each designer's capability score for each project, along with the minimum number of hours each project will require:

	Project A	Project B	Project C
Designer 1	90	80	10
Designer 2	60	70	50
Required Hours	70	45	85

Formulate a Linear Program that helps Urban Tech maximise the total capability.

[14 marks]

(b) Solve the following Linear Program:

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

subject to

$$\begin{aligned} x_1 - x_2 + x_3 &\leq 5 \\ 2x_2 + x_3 &\leq 4 \\ x_1 &\leq 3 \\ x_1, \quad x_2, \quad x_3 &\geq 0. \end{aligned}$$

[11 marks]

Soalan 1

(a) *Urban Tech Sdn. Bhd. mempunyai 2 pereka yang sedia melibatkan diri dalam 3 projek seterusnya. Setiap pereka mempunyai maksimum 80 jam bekerja yang boleh digunakan untuk mana-mana projek. Jadual berikut menunjukkan skor keupayaan setiap pereka bagi setiap projek bersama-sama bilangan jam minimum yang diperlukan oleh setiap projek.*

	Projek A	*Projek B*	*Projek C*
Pereka 1	90	80	10
Pereka 2	60	70	50
Bilangan Jam Diperlukan	70	45	85

Rangkakan suatu model Pengaturcaraan Linear untuk membantu Urban Tech memaksimumkan jumlah keupayaan.

[14 markah]

(b) *Selesaikan model Pengaturcaraan Linear berikut:*

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

terhadap

$$\begin{aligned} x_1 - x_2 + x_3 &\leq 5 \\ 2x_2 + x_3 &\leq 4 \\ x_1 &\leq 3 \\ x_1, \quad x_2, \quad x_3 &\geq 0. \end{aligned}$$

[11 markah]

Question 2

Consider the following Linear Program:

$$\text{maximise} \quad z = 5x_1 + 2x_2$$

subject to

$$\begin{aligned} x_1 - x_2 &\geq 0 \\ 2x_1 - 3x_2 &\leq 0 \\ 3x_1 &\leq 18 \\ x_1, \quad x_2 &\geq 0. \end{aligned}$$

(a) Solve the Linear Program using the Graphical Method. [7 marks]

(b) What are the ranges of feasibility for the right-hand side values (RHSs) of all constraints in the Linear Program?

[6 marks]

(c) Determine the new z^*-value if the right-hand side value (RHS) of constraint 1 is changed to $\triangle$.

[6 marks]

(d) Determine the dual price for constraint 1. [6 marks]

Soalan 2

Pertimbangkan model Pengaturcaraan Linear berikut:

$$\textit{memaksimumkan} \quad z = 5x_1 + 2x_2$$

terhadap

$$\begin{aligned} x_1 - x_2 &\geq 0 \\ 2x_1 - 3x_2 &\leq 0 \\ 3x_1 &\leq 18 \\ x_1, \quad x_2 &\geq 0. \end{aligned}$$

(a) *Selesaikan model Pengaturcaraan Linear tersebut menggunakan Kaedah Graf.* *[7 markah]*

(b) *Apakah julat kesauran untuk nilai-nilai sebelah kanan buat semua kekangan di dalam model Pengaturcaraan Linear tersebut?* *[6 markah]*

(c) *Tentukan nilai baru bagi z^* jika nilai sebelah kanan bagi kekangan 1 diubah ke $\triangle$.* *[6 markah]*

(d) *Tentukan harga dual bagi kekangan 1.* *[6 markah]*

Question 3

Action Comics Studios is about to begin production on its most important movie this year, Condiment Man. Production begins this week, and the producer Kenneth Feike has decided to use CPM/PERT to plan his project. Kenneth has identified the activities necessary to occur before the movie can be released. The activities, their precedence relations, durations and costs are as follows:

Activity	A	B	C	D	E	F	G	H
Preceding Activities	-	-	A	A	B	B	C, E	D, F
Duration (week)	5	3	4	6	5	7	9	8
Cost ($million)	20	10	16	25	22	30	25	30

(a) Construct an arrow diagram for this project. Show the earliest and latest event times on the diagram.

[5 marks]

(b) What is the cost (in $million) of producing Condiment Man? How long (in weeks) before Condiment Man can be released when production starts? Which activities are in the critical path?

[3 marks]

(c) Kenneth recently learned that Action Comics Studios' rival BS Comics Studios are also releasing a movie when Condiment Man is scheduled to be released. After a long discussion with Action Comics boss Stan Zee, the project duration has been changed to 15 weeks. Given the following information, help Kenneth determine the least costly way of crashing his project.

Activity	A	B	C	D	E	F	G	H
Crash Time (week)	3	2	2	3	4	4	5	6
Crash Cost ($million)	30	20	24	43	30	48	45	44

Report the list of activities crashed and their reduction in number of weeks, along with the new cost to produce Condiment Man.

[17 marks]

Soalan 3

Dalam masa terdekat, Action Comics Studios akan memulakan proses penghasilan filem terpenting tahun ini buat mereka, Condiment Man. Proses tersebut bermula minggu ini dan penerbit filem Kenneth Feike telah membuat keputusan untuk menggunakan CPM/PERT untuk merancang projeknya. Kenneth telahpun mengenal pasti aktiviti-aktiviti yang perlu dijalankan sebelum filemnya boleh ditayang di pawagam. Aktiviti-aktiviti tersebut, aktiviti-aktiviti pendahulu, tempoh dan kos adalah seperti berikut:

Aktiviti	A	B	C	D	E	F	G	H
Aktiviti Dahulu	-	-	A	A	B	B	C, E	D, F
Tempoh (minggu)	5	3	4	6	5	7	9	8
Kos ($juta)	20	10	16	25	22	30	25	30

(a) *Lakarkan gambarajah aliran projek ini. Tunjukkan masa terawal and terlewat buat setap acara di atas gambarajah.*

[5 markah]

(b) *Berapakah kos (dalam $juta) untuk menghasilkan Condiment Man? Berapa lamakah (dalam minggu) sebelum Condiment Man boleh ditayangkan di pawagam? Apakah aktiviti-aktiviti yang genting?*

[3 markah]

(c) *Kenneth mendapat tahu bahawa pesaing Action Comics Studios, BS Comics Studios juga akan mengeluarkan suatu filem pada masa yang sama dengan Condiment Man. Setelah berbincang panjang dengan bos Action Comics, Stan Zee, tempoh projek diubah kepada 15 minggu. Diberi maklumat di bawah, bantu Kenneth mengenalpasti cara memampatkan projeknya dengan kos terendah.*

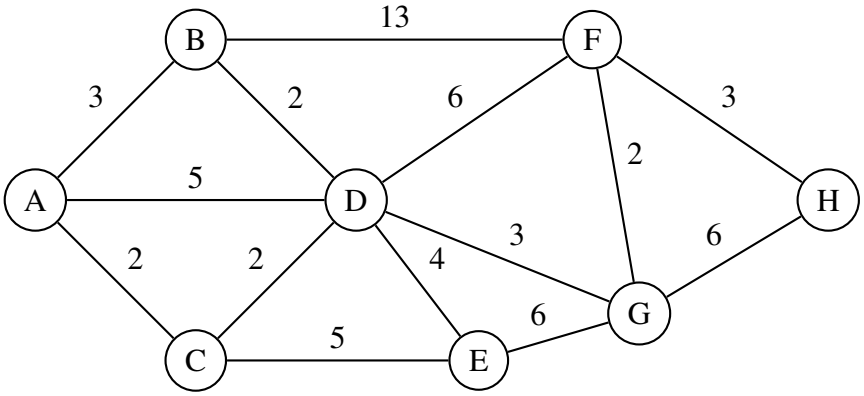
Aktiviti	A	B	C	D	E	F	G	H
Tempoh Mampat (minggu)	3	2	2	3	4	4	5	6
Kos Mampat ($juta)	30	20	24	43	30	48	45	44

Laporkan senarai aktiviti yang dimampat berserta tempoh pengurangan, dan kos penghasilan baru buat Condiment Man.

[17 markah]

Question 4

(a) Consider the following network:



(i) Use Dijkstra's Algorithm to find the shortest path from A to H and its length.

[11 marks]

(ii) Find the Minimum Spanning Tree for the network and its length.

[7 marks]

(b) Specify the range for the value of the following game. Assume the payoff is for Player A.

		Player B			
		B_1	B_2	B_3	B_4
Player A	A_1	1	9	6	0
	A_2	2	3	8	4
	A_3	-5	-2	10	-3
	A_4	7	4	-2	-5

[3 marks]

(c) Two 2-person teams are playing hide-and-seek. There are 4 hiding locations: A, B, C and D. The members of the hiding team must hide in separate locations. The searching team can only search 2 of the locations. The hiding team:

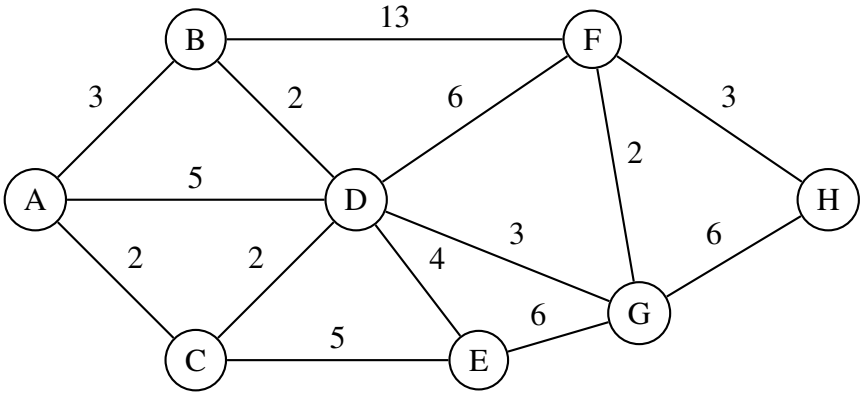
- Wins if neither member is found by the searching team.
- Loses if both members are found by the searching team.
- Draws if only one member is found by the searching team.

Provide a payoff matrix for the hiding team. Give 1 point for a win, -1 for a loss and 0 for a draw. Do not solve the game.

[4 marks]

Soalan 4

(a) *Pertimbangkan rangkaian berikut:*



(i) *Gunakan Algoritma Dijkstra untuk mendapatkan jalan terpendek dari A ke H dan jaraknya.* *[11 markah]*

(ii) *Dapatkan Pokok Rentangan Minimum bagi rangkaian tersebut dan jaraknya.* *[7 markah]*

(b) *Nyatakan julat nilai permainan berikut. Andaikan ganjaran adalah untuk Pemain A.*

		Pemain B			
		B_1	B_2	B_3	B_4
Pemain A	A_1	1	9	6	0
	A_2	2	3	8	4
	A_3	-5	-2	10	-3
	A_4	7	4	-2	-5

[3 markah]

(c) *Dua pasukan 2 orang sedang bermain sorok-sorok. Terdapat 4 lokasi untuk bersembunyi: A, B, C dan D. Ahli-ahli pasukan sembunyi mesti bersembunyi di lokasi yang berasingan. Pasukan cari hanya boleh mencari di 2 lokasi. Pasukan sembunyi akan:*

- *Menang jika kedua-dua ahli tidak dijumpai oleh pasukan cari.*
- *Kalah jika kedua-dua ahli dijumpai oleh pasukan cari.*
- *Seri dengan pasukan cari jika hanya seorang ahli dijumpai.*

Sediakan suatu matriks ganjaran untuk pasukan sembunyi. Berikan 1 markah bagi kemenangan, -1 bagi kekalahan dan 0 bagi keputusan seri. Jangan selesaikan permainan ini.

[4 markah]