Second Semester Examination
Academic Session 2017/2018

May/June 2018

EMT 302 – Mathematical Modelling In Engineering
[Pemodelan Matematik Di Dalam Kejuruteraan]

Duration : 3 hours
[Masa : 3 jam]

Please check that this paper contains **FIVE [5]** printed pages before you begin the examination.

*[Sila pastikan bahawa kertas soalan ini mengandungi **LIMA [5]** mukasurat bercetak sebelum anda memulakan peperiksaan.]*

INSTRUCTIONS : Answer **ALL THREE [3]** questions.
*[**ARAHAN** : Jawab **SEMUA TIGA [3]** 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] Describe the differences between Phenomenological and Mechanistic model. Description should also include some sketches to distinguish between the different models.

Bincangkan perbezaan antara model Phenomenological dan Mekanistik. Sila gunakan lakaran untuk menunjukkan perbezaan antara model-model ini.

(30 marks/*markah*)

[b] Suppose there are two petrol stations as shown in Figure 1.

Andaikan ada dua stesen minyak petrol seperti Rajah 1.

- **Let P^* represent the price per liter at the station along our route and P the price per liter at the station being considered.**
  Katakan P^* mewakili harga seliter di stesen sepanjang laluan dan P harga seliter di stesen yang dipertimbangkan.

- **Let D represent the distance in meter from the normal route that must be driven to get back and forth the other station.**
  Katakan D mewakili jarak dalam meter dari laluan biasa yang mesti dilalui untuk pergi dan balik dari stesen lain.

- **Let M represent the average fuel efficiency of the car being driven.**
  Katakan M mewakili purata keberkesanan bahan api kereta yang dipandu.

- **Let T represent the number of liter of petrol purchased.**
  Katakan T mewakili bilangan liter petrol yang dibeli.

(i) Develop an algebraic equation to describe the
Binakan persamaan algebra untuk menerangkan

- **cost per usable liter**
  kos penggunaan setiap liter

- **meters of driving**
  meter pemanduan

(ii) **Draw three (3) level curves for I = 2, 3 & 4 to represent the cost per useable liter for M = 15 and T = 20.**
Lukis tiga (3) lengkung paras bagi I = 2, 3 & 4 untuk mewakili kos penggunann setiap liter untuk M = 15 dan T = 20.

(iii) **Suppose you are considering a station 10 meters away, based on the the level curves, what is lowest price per liter, P of the considered station if the price per liter, P^* for the station along the route is RM 1.85?**
Sekiranya anda sedang mempertimbang stesen yang 10 meter jauhnya, berdasarkan lengkung paras yang dibina, berapakah harga terendah seliter, P bagi stesen yang dipertimbangkan sekiranya harga seliter, P bagi stesen dalam perjalanan ialah RM 1.85?

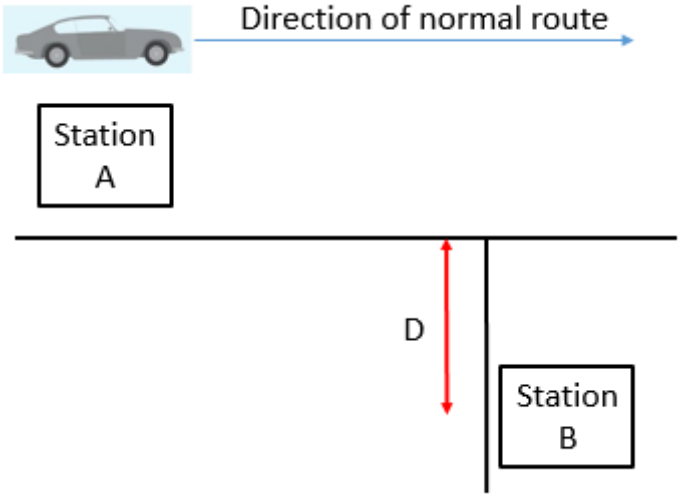

Figure 1
Rajah 1

(70 marks/*markah*)

2. **[a]** **Use the Chebyshev Approximation Criterion to fit the model $y = cx$ to the following data set. Use the graphical method to identify the minimum value of c and r.**

Gunakan Kriteria Penghampiran Chebyshev untuk memadankan model $y = cx$ ke set data dalam Jadual 1. Gunakan kaedah grafik untuk mengenalpasti nilai minimum c dan r.

Table 2[a]
Jadual 2[a]

x	1	2	3
y	2	5	8

(40 marks/*markah*)

[b] (i) Discuss the issues relating to high order polynomial models.
Bincangkan isu-isu yang berkaitan dengan model polinomial kuasa tinggi.

(ii) In the following data in Table 2, X represents the diameter of a ponderosa pine measured at chest height, and Y is a measure of volume. Construct a divided difference table. Discuss on the possible polynomial order based on the constructed divided difference table.
Berdasarkan data berikut dalam Jadual 2, X mewakili diameter pinus ponderosa diukur pada ketinggian di dada, dan Y ialah ukuran isipadu. Bina jadual perbezaan pembahagian. Bincangkan susunan polinomial yang boleh dipilih berdasarkan jadual perbezaan pembahagian.

Table 2[b]
Jadual 2[b]

X	17	19	20	22	23	25	31	32	33	36	37	38	39	41
Y	19	25	32	51	57	71	141	123	187	192	205	252	248	294

(60 marks/*markah*)

3. [a] Discuss the differences between Lagrangian and Eulerian based grid. Please use a sketch to demonstrate the differences between these methods.

Bincangkan perbezaan antara kaedah Lagrangian dan Eulerian. Sila gunakan lakaran untuk menunjukkan perbezaan antara kaedah-kaedah ini.

(30 marks/*markah*)

[b] Discuss the formulation of Bounce Back scheme on the following collision "look up" table as shown in Table 3[b].

Bincangkan kaedah formulasi skema Lantunan Kembali pada jadual "mencari" perlanggaran berikut seperti dalam Jadual 3[b].

Table 3[b]
Jadual 3[b]

	Out-State Bit Value							
	128 R	64 S	32 F	16 E	8 D	4 C	2 B	1 A
64	0	1	0	0	0	0	0	0
72	0	1	0	0	1	0	0	0
80	0	1	0	1	0	0	0	0
…								
127	0	1	1	1	1	1	1	1

(20 marks/*markah*)

[c]

(a) The use of smoothing length of the support domain is in direct violation of Newton's Third Law. Discuss the reason for this issue and *one* method to treat this issue.

Penggunaan pelonggaran panjang bagi domain sokongan adalah menyalahi Hukum Ketiga Newton. Bincangkan sebab untuk isu ini dan satu kaedah untuk mengatasi masalah ini.

(b) The dome-shaped quadratic smoothing function with scaling factor, $\kappa = 1$ is given as:

Fungsi peralihan berbentuk kubah bagi fungsi pelonggaran kuadratik dengan faktor skala, κ = 1 diberikan sebagai:

$$W(R,h) = (a_0 + a_2 R^2)$$
$$with\ R = \frac{r}{h}$$

(i) Calculate the value of α_d for 3-dimensional (3D) case that satisfy the compact support constraint requirement:

Kirakan nilai α_d untuk kes 3 dimensi (3D) yang memenuhi keperluan kekangan sokongan padat

$$W(R, h) = \alpha_d(1 - R^2)$$

(50 marks/*markah*)

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