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UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
2014/2015 Academic Session

June 2015

**MSG 389 – Engineering Computation II**  
***[Pengiraan Kejuruteraan II]***

Duration : 3 hours  
*[Masa : 3 jam]*

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

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMA muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

**Instructions:** Answer **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) Find  $y(0.1)$  using Runge Kutta method of order four by solving the IVP  $y' = -2xy^2, y(0) = 1$  with step length 0.1. Also compare the solution obtained with RungeKutta methods of order three and two.

[ 40 marks ]

- (b) Obtain the approximate value of  $y(0.3)$  for the initial value problem

$$y' = x^2 + y^2, \quad y(0) = 1$$

using the predictor-corrector method:

$$\text{Predictor: } y_{i+1}^{(p)} = y_i + hf_i$$

$$\text{Corrector: } y_{i+1}^{(c)} = y_i + \frac{h}{2} [f_i + f_{i+1}]$$

with the step length  $h=0.1$ . Perform two corrector per step.

[ 60 marks ]

1. (a) *Dapatkan nilai  $y(0.1)$  menggunakan kaedah Runge Kutta tertib empat bagi menyelesaikan masalah nilai awalan  $y' = -2xy^2, y(0) = 1$  dengan saiz langkah 0.1. Bandingkan juga penyelesaian yang didapati dengan kaedah Runge Kutta tertib ketiga dan kedua.*

[ 40 markah ]

- (b) *Dapatkan nilai anggaran untuk  $y(0.3)$  bagi masalah nilai awalan:*

$$y' = x^2 + y^2, \quad y(0) = 1$$

*dengan menggunakan kaedah penganggaran dan pembaikan :*

$$\text{Penganggaran: } y_{i+1}^{(p)} = y_i + hf_i$$

$$\text{Pembaikan: } y_{i+1}^{(c)} = y_i + \frac{h}{2} [f_i + f_{i+1}]$$

*dengan saiz langkah  $h=0.1$ . Lakukan dua pembaikan untuk setiap langkah.*

[ 60 markah ]

2. (a) Consider a tank with volume 100 liters containing a salt solution. Suppose a solution with 2kg/liter of salt flows into the tank at a rate of 5 liters/min. The solution in the tank is well mixed. Solution flows out of the tank at a rate of 5 liters/min. If initially there is 20 kg of salt in the tank, how much salt will be in the tank as a function of time?

[ 30 marks ]

- (b) Police arrive at the scene of a murder at 12 am. They immediately take and record the body's temperature, which is 90°F, and thoroughly inspect the area. By the time they finish the inspection, it is 1.30 am. They again take the temperature of the body, which has dropped to 87°F, and have it sent to the morgue. The temperature at the crime scene has remained steady at 82°F. What time did the crime occurred?

[ 30 marks ]

- (c) Solve the following ordinary differential equation using finite difference with  $\Delta x = 0.5$ .

$$\frac{d^2y}{dx^2} - \left(1 - \frac{x}{5}\right)y = x; \quad y(1) = 2, \quad y(3) = -1$$

[ 40 marks ]

2. (a) *Andaikan suatu tangki dengan isipadu 100 liter mengandungi larutan garam. Sekiranya suatu larutan mengandungi garam sebanyak 2kg/liter mengalir ke dalam tangki dengan kadar 5 liter/min. Larutan dalam tangki tersebut adalah sekata. Larutan mengalir keluar dari pada tangki dengan kadar 5 liter/min. Jika pada awalnya terdapat 20 kg garam di dalam tangki, berapakah kuantiti garam dalam tangki tersebut dalam fungsi masa?*

[ 30 markah ]

- (b) *Polis tiba di tempat pembunuhan pada pukul 12 tengah malam. Mereka dengan segeranya merekodkan suhu mayat iaitu, 90°F, dan memeriksa tempat kejadian dengan teliti. Setelah mereka habis memeriksa, jam menunjukkan pukul 1.30 pagi. Mereka merekodkan suhu mayat sekali lagi, dan telah jatuh ke suhu 87°F, dan menghantarnya ke rumah mayat. Suhu di tempat kejadian kekal mantap pada 82°F. Pukul berapakah pembunuhan itu telah berlaku?*

[ 30 markah ]

- (c) *Selesaikan masalah pembezaan biasa berikut menggunakan kaedah beza terhingga dengan  $\Delta x = 0.5$*

$$\frac{d^2y}{dx^2} - \left(1 - \frac{x}{5}\right)y = x; \quad y(1) = 2, \quad y(3) = -1$$

[ 40 markah ]

3. (a) Consider the linear boundary value problem with Dirichlet boundary conditions

$$-u'' + \pi^2 u = 2\pi^2 \sin(\pi x)$$

$$u(0) = u(1) = 0$$

Solve the boundary value problem using shooting method with  $h = 0.5$ .

[ 50 marks ]

- (b) Write down the system of linear equation ( $Ax = b$ ) for steady-state temperature distribution in a rectangular plate of size  $15'' \times 20''$  by solving the Laplace equation  $\Delta x = \Delta y = 5''$ . The temperatures on the four sides of the plate are specified as indicated in figure below.

[ 50 marks ]

3. (a) *Pertimbangkan masalah linear nilai sempadan dengan syarat Dirichlet:*

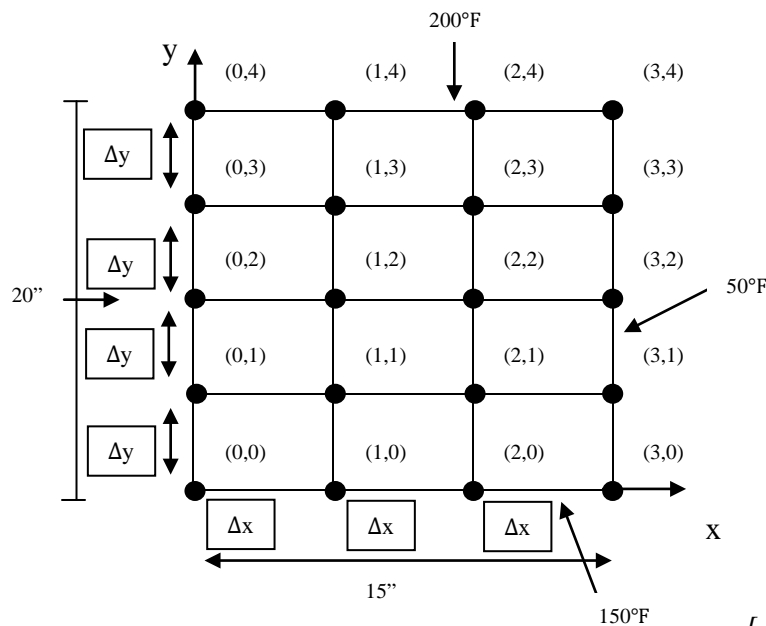
$$-u'' + \pi^2 u = 2\pi^2 \sin(\pi x)$$

$$u(0) = u(1) = 0$$

*Selesaikan masalah nilai sempadan menggunakan kaedah tembakan dengan  $h = 0.5$ .*

[50 markah]

- (b) *Tuliskan sistem persamaan linear ( $Ax = b$ ) untuk taburan suhu mantap bagi suatu pinggan segiempat bersaiz  $15'' \times 20''$  dengan menyelesaikan persamaan Laplace  $\Delta x = \Delta y = 5''$ . Suhu di keempat sisi pinggan adalah seperti gambarajah di bawah.*



[ 50 markah ]

4. (a) A metal rod of length 1 meter is initially at  $70^{\circ}\text{C}$ . The steady state temperature of the left and right ends of the rod are given by  $50^{\circ}\text{C}$  and  $20^{\circ}\text{C}$  respectively. Using  $\alpha^2 = 0.1 \text{ m}^2/\text{min}$ ,  $\Delta x = 0.2 \text{ m}$  and  $\Delta t = 0.1 \text{ min}$ , determine the temperature in the rod for  $0 \leq t \leq 0.3 \text{ min}$ .
- (b) Solve the same problem by using Crank Nicholson method with  $\Delta x = 0.2 \text{ m}$  and  $\Delta t = 0.3 \text{ min}$ .

[ 100 marks ]

4. (a) Suatu rod besi dengan panjang 1 meter pada awalnya bersuhu  $70^{\circ}\text{C}$ . Suhu mantap pada sebelah kanan dan kiri rod adalah masing-masing  $50^{\circ}\text{C}$  dan  $20^{\circ}\text{C}$  masing-masing. Dengan menggunakan  $\alpha^2 = 0.1 \text{ m}^2/\text{min}$ ,  $\Delta x = 0.2 \text{ m}$  dan  $\Delta t = 0.1 \text{ min}$ , tentukan suhu dalam rod untuk  $0 \leq t \leq 0.3 \text{ min}$ .
- (b) Selesaikan masalah yang sama menggunakan kaedah Crank Nicholson dengan  $\Delta x = 0.2 \text{ m}$  dan  $\Delta t = 0.3 \text{ min}$ .

[ 100 markah ]