UNIVERSITI PUTRA MALAYSIA

BLOCK BACKWARD DIFFERENTIATION METHODS FOR SINGLE DELAY DIFFERENTIAL EQUATIONS

HENG SIAW CHING

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BLOCK BACKWARD DIFFERENTIATION METHODS FOR SINGLE DELAY DIFFERENTIAL EQUATIONS

By

HENG SIAW CHING

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

November 2012

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DEDICATION

To

My Beloved Family

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

BLOCK BACKWARD DIFFERENTIATION METHODS FOR SINGLE DELAY DIFFERENTIAL EQUATIONS

By

HENG SIAW CHING

November 2012

Chairman: Zarina Bibi Ibrahim, PhD

Faculty: Science

This thesis concerns mainly in modifying existence method of Block Backward Differentiation Formulas (BBDFs) for solving stiff single Delay Differential Equations (DDEs). The method involved will solve the first order single DDEs using constant stepsize. The general equation for single DDEs is given as follows

$$y'(x) = f\big(x, y, y(x-\tau)\big), \quad x \geq x_0$$

$$y(x) = \phi(x), \quad x \leq x_0$$

The method is adapted with Newton Divided Difference interpolation to approximate delay term. The performance of 2-point BBDFs method and 3-point BBDFs method is compared with classical 1-point Backward Differentiation Formulas (BDFs). The source code is written in C language. Numerical results

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showed the method gave good results in term in maximum error and comparable results in term of execution time.

In addition, the stability region of BBDFs method is obtained and it is applied to solve DDEs. The illustrations of the stability region are presented.

In conclusion, the Block Backward Differentiation Formulas method is appropriate for solving the first order stiff single Delay Differential Equations.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

KAEDAH FORMULA PEMBEZAAN BLOK KE BELAKANG UNTUK MENYELESAIKAN PERSAMAAN PEMBEZAAN SATU SEBUTAN LENGAH

Oleh

HENG SIAW CHING

November 2012

Pengerusi: Zarina Bibi Ibrahim, PhD

Fakulti: Sains

Tesis ini bertumpu kepada pengolahan kaedah Formula Pembezaan Blok Ke Belakang (FPBB) yang sedia ada dalam menyelesaikan Persamaan Pembezaan Satu Sebutan Lengah (PPL) yang kaku. Kaedah tersebut akan menyelesaikan PPL peringkat pertama dengan menggunakan saiz langkah malar. Persamaan umum PPL adalah seperti berikut

$$y'(x) = f\big(x, y, y(x-\tau)\big), \quad x \geq x_0$$

$$y(x) = \phi(x), \quad x \leq x_0$$

Kaedah tersebut diubahsuai dengan Interpolasi Beza Bahagi Newton untuk menganggarkan sebutan lengah. Prestasi kaedah FPBB 2-titik dan kaedah FPBB

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3-titik dibandingkan dengan kaedah klasik 1-titik Formula Pembezaan Ke Belakang (FPB). Kod program adalah ditulis dalam pengaturcaraan C. Hasil numerikal menunjukkan kaedah tersebut memberikan hasil yang baik dari segi ralat maksimum dan hasil yang memuaskan dari segi masa pelaksanaan.

Di samping itu, ruang kestabilan untuk kaedah FPBB diperoleh dan diaplikasikan untuk menyelesaikan PPL. Illustrasi ruang kestabilan juga ditunjukkan.

Sebagai kesimpulan, Formula Pembezaan Blok Ke Belakang adalah sesuai untuk menyelesaikan Persamaan Pembezaan Satu Sebutan Lengah peringkat pertama yang kaku.

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I certify that a Thesis Examination Committee has met on (27 November 2012) to conduct the final examination of Heng Siaw Ching on her thesis entitled "BLOCK BACKWARD DIFFERENTIATION METHOD FOR SINGLE DELAY DIFFERENTIAL EQUATIONS" in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

_____

HENG SIAW CHING

Date: 27 November 2012

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