## LAMPIRAN I PROGRAM ADAMS

```
    PROGRAM ADAMS(INPUT,OUTPUT);
    USES CRT;
    TYPE
        L = ARRAY [0..100] OF REAL;
    LABEL
         100,SELESAI;
    VAR
       I,J,FLAG,LAST,NFLAG,N,K          : INTEGER;
       A,B,YA,H,K1,K2,K3,K4,WP,WC,E1    : REAL;
       TOL,XX,F1,HMAX,HMIN,T,Q,WAM,E2   : REAL;
       WAB,Y1                           : REAL;
       X,W                              : L;
       JAWAB1,JAWAB2,PIL                : CHAR;
{awal fungsi F}
    FUNCTION F(X,W : REAL):REAL;
    BEGIN
         F := (-1 * W) + X + 1
    END;{akhir fungsi F}
{awal fungsi Y}
    FUNCTION Y(X : REAL):REAL;
    BEGIN
         Y := X + EXP(-X)
    END;{akhir fungsi Y}
{awal prosedur masukan}
    PROCEDURE MASUKAN;
    BEGIN
         WRITELN;
         WRITELN('  PROGRAM MENGHITUNG SOLUSI',
                 '  PERSAMAAN DIFERENSIAL BIASA');
         WRITELN;
         WRITELN('  dy/dx = x - y + 1'  );
         WRITELN;
         WRITELN('  MENGGUNAKAN METODE',
                 '  PREDIKTOR-KOREKTOR ADAMS');
         WRITELN('  DENGAN RUMUS PREDIKTOR ADAMS-BASHFORT');
         WRITELN('  DAN RUMUS KOREKTOR ADAMS-MOULTON');
         WRITELN('  SECARA NUMERIK');
         WRITELN;
         WRITELN('  DISUSUN OLEH : ');
         WRITELN('  DWI WAHYUNI ');
         WRITELN('  J 101 94 1010 ');
         WRITELN;
         WRITE('  Masukkan nilai batas bawah            = ');
         READ(A);
         WRITE('  Masukkan nilai batas atas             = ');
         READLN(B);
         WRITE('  Masukkan harga Y(A)                   = ');
         READLN(Y1);
         WRITE('  Masukkan harga toleransi TOL          = ');
         READLN(TOL);
         WRITE('  Masukkan ukuran langkah maksimum HMAX = ');
```

## LAMPIRAN I PROGRAM ADAMS

```
        READLN(HMAX);
        WRITE('  Masukkan ukuran langkah minimum HMIN  = ');
        READLN(HMIN);
        WRITELN
    END;{akhir prosedur MASUKAN}
{awal prosedur PILIHAN}
    PROCEDURE PILIHAN;
    BEGIN
        CLRSCR;
        WRITELN;
        WRITELN('      MENU PILIHAN ANDA : ');
        WRITELN('  A : METODE ADAMS-BASHFORT ORDE 4 ');
        WRITELN('  B : METODE PREDIKTOR-KOREKTOR ADAMS ');
        WRITELN('  C : METODE PREDIKTOR-KOREKTOR ADAMS ');
        WRITELN('      DENGAN PENGENDALIAN UKURAN LANGKAH ');
        WRITELN('  D : SELESAI');
        WRITELN;
        WRITE('  PILIHAN ANDA = ');
        READLN(PIL);
        WRITELN
    END;{akhir prosedur PILIHAN}
{awal prosedur RK4}
    PROCEDURE RK4(VAR H   : REAL;
                  VAR N   : INTEGER;
                  VAR W,X : L);
    BEGIN
        FOR J := N TO N+2 DO
        BEGIN
            K1   := H*F(X[J-1],W[J-1]);
            K2   := H*F(X[J-1]+H/2,W[J-1]+K1/2);
            K3   := H*F(X[J-1]+H/2,W[J-1]+K2/2);
            K4   := H*F(X[J-1]+H,W[J-1]+K3);
            W[J] := W[J-1] + (K1+2*K2+2*K3+K4)/6;
            X[J] := X[0] + J*H;
        END;
    END;{akhir prosedur RK4}
{awal prosedur HITUNG}
    PROCEDURE HITUNG(VAR K   : INTEGER;
                     VAR H   : REAl;
                     VAR X,W : L);
    BEGIN
        WP := W[K-1] + H*(55*F(X[K-1],W[K-1])
              -59*F(X[K-2],W[K-2])
              +37*F(X[K-3],W[K-3])
              -9*F(X[K-4],W[K-4]))/24;
        WC := W[K-1] + H*(9*F(XX,WP)
              +19*F(X[K-1],W[K-1])
              -5*F(X[K-2],W[K-2])
              +F(X[K-3],W[K-3]))/24;
        T  := (19 * ABS(WC-WP))/(270*H);
```

## LAMPIRAN I PROGRAM ADAMS

```
    END;{akhir prosedur HITUNG}
{awal prosedur GARIS}
    PROCEDURE GARIS;
    BEGIN
         WRITELN('-------------------------------------------------',
         '-------------------------');
    END;{akhir prosedure garis}
{awal prosedur AB}
    PROCEDURE AB;
    BEGIN
         GOTOXY(5,5);
         WRITELN;
         WRITE('  MASUKKAN HARGA H PENDEKATAN : ');
         READLN(H);
         WRITELN;
         I := 1;
         RK4(H,I,W,X);
         GOTOXY(1,5);
         WRITELN('-------------------------------------');
         WRITELN(' X[i]    Y[i]       WAB    PERSENTASE');
         WRITELN('                           e relatif(%)');
         WRITELN('-------------------------------------');
         FOR J := I-1 TO I+2 DO
         BEGIN
              YA  := Y(X[J]);
              WRITELN(X[J]:4:2,' ',YA:8:5)
         END;
         N := 4;
         WHILE FLAG = 1 DO
         BEGIN
              I    := 4;
              XX   := X[I-1] + H;
              X[I] := XX;
              IF X[I] <= B + H THEN
              BEGIN
                   YA  := Y(X[I]);
                   WAB := W[I-1] + H*(55*F(X[I-1],W[I-1])
                          -59*F(X[I-2],W[I-2])
                          +37*F(X[I-3],W[I-3])
                          -9*F(X[I-4],W[I-4]))/24;
                   E1   := (ABS(YA-WAB)/WAB)*100;
                   FLAG := 1;
                   IF N < 11 THEN
                   BEGIN
                        WRITELN(X[I]:4:2,' ',YA:8:5,' ',WAB:8:5,
                        ' ',E1:9:6,' ');
                        N := N + 1
                   END
                   ELSE
                   BEGIN
```

## LAMPIRAN I PROGRAM ADAMS

```
                    WRITELN('-------------------------------');
                    WRITELN;
                    WRITELN(' Silahkan tekan <ENTER> untuk',
                            'melanjutkan ');
                    READKEY;
                    CLRSCR;
                    N := 1;
                    WRITELN('-------------------------------');
                    WRITELN(' X[i]    Y[i]       WAB',
                            '    PERSENTASE');
                    WRITELN('                              e',
                            ' relatif(%)');
                    WRITELN('-------------------------------')
                END;
                FOR J:= I-4 TO I-2 DO
                BEGIN
                    X[J] := X[J+1];
                    W[J] := W[J+1]
                END;
                X[I-1] := XX;
                W[I-1] := WAB
            END
            ELSE
                FLAG := 0;
            I    := I+1;
            X[I] := X[I-1] + H;
            XX   := X[I];
        END;
        WRITELN('-----------------------------------');
    END;{akhir prosedur AB}
{awal prosedur PKA}
    PROCEDURE PKA;
    BEGIN
        GOTOXY(5,5);
        WRITELN;
        WRITE('  MASUKKAN HARGA H PENDEKATAN : ');
        READLN(H);
        WRITELN;
        I := 1;
        RK4(H,I,W,X);
        GARIS;
        WRITELN(' X[i]    Y[i]     WAB     ',
                'e1 relatif(%) WAM   e2 relatif(%)');
        GARIS;
        FOR J := 0 TO 3 DO
        BEGIN
            YA  := Y(X[J]);
            WRITELN(X[J]:4:2,' ',YA:8:5)
        END;
        N := 4;
```

## LAMPIRAN I PROGRAM ADAMS

```
WHILE FLAG = 1 DO
BEGIN
     I     := 4;
     XX    := X[I-1] + H;
     X[I]  := XX;
     IF X[I] <= B + H THEN
     BEGIN
          YA := Y(X[I]);
          WAB  := W[I-1] + H*(55*F(X[I-1],W[I-1])
             -59*F(X[I-2],W[I-2])
             +37*F(X[I-3],W[I-3])
             -9*F(X[I-4],W[I-4]))/24;
          WAM  := W[I-1] + H*(9*F(XX,WAB)
             +19*F(X[I-1],W[I-1])
             -5*F(X[I-2],W[I-2])
             +F(X[I-3],W[I-3]))/24;
          E1   := (ABS(YA-WAB)/WAB)*100;
          E2   := (ABS(YA-WAM)/WAM)*100;
          FLAG := 1;
          IF N < 11 THEN
          BEGIN
               WRITELN(X[I]:4:2,' ',YA:8:5,' ',WAB:8:5,
                       ' ',E1:9:6,'   ',WAM:8:5,
                       ' ',E2:9:6);
               N := N + 1
          END
          ELSE
          BEGIN
               GARIS;
               WRITELN;
               WRITELN(' Silahkan tekan <ENTER> ',
                       'untuk melanjutkan');
               READKEY;
               CLRSCR;
               N := 1;
               GARIS;
               WRITELN(' X[i]   Y[i]    WAB    ',
                  'e1 relatif(%) WAM   e2 relatif(%)');
               GARIS
          END;
          FOR J := I-4 TO I-2 DO
          BEGIN
               X[J] := X[J+1];
               W[J] := W[J+1]
          END;
          X[I-1] := XX;
          W[I-1] := WAM
     END
     ELSE
          FLAG := 0;
```

## LAMPIRAN I PROGRAM ADAMS

```
            I    := I+1;
            X[I] := X[I-1] + H;
        END;
        GARIS;
    END;{akhir prosedur PKA}
{awal prosedur VPKA}
    PROCEDURE VPKA;
    BEGIN
        I:= 1;
        RK4(H,I,W,X);
        NFLAG := 1;
        I     := 4;
        XX    := X[3] + H;
        X[I]  := XX;
        GARIS;
        WRITELN(' I  X[I]          W[I]          H       T',
                '          Y[I]          e relatif');
        GARIS;
        WRITELN(0:2,' ',A:8:5,' ',WC:15:10,' ',
                H:8:5,' ',T:10:8,' ',Y(A):15:10);
        N := 4;
        WHILE FLAG = 1 DO
        BEGIN
            HITUNG(I,H,X,W);
            IF T <= TOL THEN
            BEGIN
                W[I] := WC;
                X[I] := XX;
                IF NFLAG = 1 THEN
                BEGIN
                    FOR J := I-3 TO I DO
                    BEGIN
                        E1 := ABS(Y(X[J])-W[J])/W[J]*100;
                        IF N < 11 THEN
                        BEGIN
                            WRITELN(J:2,' ',X[J]:8:5,
                                    ' ',W[J]:15:10,' ',
                                    H:8:5,' ',T:10:8,
                                    ' ',Y(X[J]):15:10,' ',
                                    E1:8:6);
                            N := N + 1
                        END
                        ELSE
                        BEGIN
                            GARIS;
                            WRITELN;
                            WRITELN(' Silahkan tekan',
                              ' <ENTER> untuk melanjutkan');
                            READKEY;
                            CLRSCR;
```

## LAMPIRAN I PROGRAM ADAMS

```
                    N := 1;
                    GARIS;
                    WRITELN(' I  X[I]          W[I]',
                            '           H          T',
                            '            Y[I]',
                            '        e relatif');
                    GARIS
               END;
          END;
     END
     ELSE
     BEGIN
          E1 := ABS(Y(X[I])-W[I])/W[I]*100;
          IF N < 11 THEN
          BEGIN
               WRITELN(I:2,' ',X[I]:8:5,
                       ' ',W[I]:15:10,' ',H:8:5,
                       ' ',T:10:8,' ',Y(X[I]):15:10,
                       ' ',E1:8:6);
               N := N + 1
          END
          ELSE
          BEGIN
               GARIS;
               WRITELN;
               WRITELN(' Silahkan tekan <ENTER>',
                       ' untuk melanjutkan');
               READKEY;
               CLRSCR;
               N := 1;
               GARIS;
               WRITELN(' I  X[I]          W[I]',
                       '           H          T',
                       '            Y[I]        e',
                       ' relatif');
               GARIS
          END;
     END;
     IF LAST = 1 THEN FLAG := 0
     ELSE
     BEGIN
          I     := I+1;
          NFLAG := 0;
          IF (T <= 0.1*TOL) OR (X[I-1]+H > B) THEN
          BEGIN
               Q := EXP((1/4)*LN(TOL/(2*T)));
               IF Q > 4 THEN H := 4*H
               ELSE H := Q*H;
               IF H > HMAX THEN H := HMAX;
               IF X[I-1]+4*H > B THEN
```

## LAMPIRAN I PROGRAM ADAMS

```
                        BEGIN
                            H     := (B-X[I-1])/4;
                            LAST  := 1;
                            RK4(H,I,W,X);
                            NFLAG := 1;
                            I     := I + 3
                        END;
                    END;
                END
            END
            ELSE
            BEGIN
                Q := EXP((1/4)*LN(TOL/(2*T)));
                IF Q < 0.1 THEN H := 0.1 * H
                ELSE H := Q*H;
                IF H < HMIN THEN
                BEGIN
                    H    := HMIN;
                    FLAG := 0;
                    GARIS
                END
                ELSE
                BEGIN
                    IF NFLAG = 1 THEN I := I-3;
                    RK4(H,I,W,X);
                    I    := I+3;
                    NFLAG := 1
                END;
            END;
            XX := X[I-1] + H;
        END;
    END;{akhir prosedur VPKA}
{awal program utama}
    BEGIN
        CLRSCR;
        REPEAT
        MASUKAN;
        REPEAT;
        PILIHAN;
        IF PIL IN ['A'..'D','a'..'d'] THEN
        BEGIN
            X[0] := A;
            W[0] := Y1;
            H    := HMAX;
            FLAG := 1;
            LAST := 0;
            CLRSCR;
            WRITELN('      HASIL PERHITUNGAN UNTUK');
            WRITELN('      X(A) = ',A:8,' X(B) = ','Y(A) =',
                    ',Y1:8);
```

## LAMPIRAN I PROGRAM ADAMS

```
            WRITELN('      TOLERANSI = ',TOL:8,
                    ' H Maksimum = ',HMAX:8,' H minimum =',
                    HMIN:8);
            CLRSCR;
            CASE PIL OF
                 'A','a' : AB;
                 'B','b' : PKA;
                 'C','c' : VPKA;
                 'D','d' : GOTO 100;
            END;{akhir CASE}
            X[0] := A;
            W[0] := Y1;
            H    := HMAX;
            FLAG := 1;
            LAST := 0;
            END
            ELSE
                 WRITELN(' PILIHAN ANDA TIDAK TEPAT !!!');
          WRITELN;
          READKEY;
          WRITE('  ANDA INGIN MENGHITUNG LAGI DENGAN DATA YANG',
                ' SAMA ? (Y / T) ');
          READLN(JAWAB1);
          UNTIL (JAWAB1 = 'T') OR (JAWAB1 = 't');
          WRITELN;
          WRITE('  ANDA INGIN MENGGANTI NILAI AWAL ? (Y / T) ');
          READLN(JAWAB2);
          UNTIL (JAWAB2 = 'T') OR (JAWAB2 = 't');
          CLRSCR;
          GOTOXY(10,10);
          WRITELN(' TERIMA KASIH ATAS PERHATIAN ANDA');
          READKEY;
          100    : GOTOXY(10,10);
                   WRITELN(' TERIMA KASIH ATAS PERHATIAN ANDA');
                   READKEY;
          SELESAI:
END.{akhir program utama}
```

## LAMPIRAN II OUTPUT PROGRAM ADAMS

```
PROGRAM MENGHITUNG SOLUSI  PERSAMAAN DIFERENSIAL BIASA

dy/dx = x - y + 1

MENGGUNAKAN METODE  PREDIKTOR-KOREKTOR ADAMS
DENGAN RUMUS PREDIKTOR ADAMS-BASHFORT
DAN RUMUS KOREKTOR ADAMS-MOULTON
SECARA NUMERIK

DISUSUN OLEH :
DWI WAHYUNI
J 101 94 1010

Masukkan nilai batas bawah              = 0
Masukkan nilai batas atas               = 2
Masukkan harga Y(A)                     = 1
Masukkan harga toleransi TOL            = 0.00001
Masukkan ukuran langkah maksimum HMAX   = 0.25
Masukkan ukuran langkah minimum HMIN    = 0.02


     MENU PILIHAN ANDA :
A  :  METODE ADAMS-BASHFORT ORDE 4
B  :  METODE PREDIKTOR-KOREKTOR ADAMS
C  :  METODE PREDIKTOR-KOREKTOR ADAMS
      DENGAN PENGENDALIAN UKURAN LANGKAH
D  :  SELESAI

PILIHAN ANDA = A
```

MASUKKAN HARGA H PENDEKATAN : 0.13

| X[i] | Y[i] | WAB | PERSENTASE13 e relatif(%) |
|---|---|---|---|
| 0.00 | 1.00000 | | |
| 0.13 | 1.00810 | | |
| 0.26 | 1.03105 | | |
| 0.39 | 1.06706 | | |
| 0.52 | 1.11452 | 1.11453 | 0.000958 |
| 0.65 | 1.17205 | 1.17206 | 0.001406 |
| 0.78 | 1.23841 | 1.23843 | 0.001828 |
| 0.91 | 1.31252 | 1.31255 | 0.001971 |
| 1.04 | 1.39345 | 1.39348 | 0.002053 |
| 1.17 | 1.48037 | 1.48040 | 0.002018 |
| 1.30 | 1.57253 | 1.57256 | 0.001950 |

Silahkan tekan <ENTER> untuk melanjutkan

| X[i] | Y[i] | WAB | PERSENTASE e relatif(%) |
|---|---|---|---|
| 1.56 | 1.77014 | 1.77017 | 0.001711 |
| 1.69 | 1.87452 | 1.87455 | 0.001574 |
| 1.82 | 1.98203 | 1.98205 | 0.001437 |
| 1.95 | 2.09227 | 2.09230 | 0.001303 |
| 2.08 | 2.20493 | 2.20496 | 0.001176 |

ANDA INGIN MENGHITUNG LAGI DENGAN DATA YANG SAMA ? (Y / T) Y

```
     MENU PILIHAN ANDA :
A  : METODE ADAMS-BASHFORT ORDE 4
B  : METODE PREDIKTOR-KOREKTOR ADAMS
C  : METODE PREDIKTOR-KOREKTOR ADAMS
     DENGAN PENGENDALIAN UKURAN LANGKAH
D  : SELESAI

PILIHAN ANDA = B


MASUKKAN HARGA H PENDEKATAN : 0.13
```

| X[i] | Y[i] | WAB | e1 relatif(%) | WAM | e2 relatif(%) |
|---|---|---|---|---|---|
| 0.00 | 1.00000 | | | | |
| 0.13 | 1.00810 | | | | |
| 0.26 | 1.03105 | | | | |
| 0.39 | 1.06706 | | | | |
| 0.52 | 1.11452 | 1.11453 | 0.000958 | 1.11452 | 0.000051 |
| 0.65 | 1.17205 | 1.17205 | 0.000732 | 1.17204 | 0.000130 |
| 0.78 | 1.23841 | 1.23841 | 0.000517 | 1.23840 | 0.000180 |
| 0.91 | 1.31252 | 1.31253 | 0.000375 | 1.31252 | 0.000209 |
| 1.04 | 1.39345 | 1.39346 | 0.000261 | 1.39345 | 0.000222 |
| 1.17 | 1.48037 | 1.48037 | 0.000174 | 1.48036 | 0.000225 |
| 1.30 | 1.57253 | 1.57253 | 0.000110 | 1.57253 | 0.000220 |

```
 Silahkan tekan <ENTER> untuk melanjutkan
```

| X[i] | Y[i] | WAB | e1 relatif(%) | WAM | e2 relatif(%) |
|---|---|---|---|---|---|
| 1.56 | 1.77014 | 1.77014 | 0.000029 | 1.77013 | 0.000197 |
| 1.69 | 1.87452 | 1.87452 | 0.000005 | 1.87452 | 0.000183 |
| 1.82 | 1.98203 | 1.98203 | 0.000012 | 1.98202 | 0.000168 |
| 1.95 | 2.09227 | 2.09227 | 0.000023 | 2.09227 | 0.000153 |
| 2.08 | 2.20493 | 2.20493 | 0.000030 | 2.20493 | 0.000138 |

```
  ANDA INGIN MENGHITUNG LAGI DENGAN DATA YANG SAMA ? (Y / T) Y
```

```
     MENU PILIHAN ANDA :
A  :  METODE ADAMS-BASHFORT ORDE 4
B  :  METODE PREDIKTOR-KOREKTOR ADAMS
C  :  METODE PREDIKTOR-KOREKTOR ADAMS
      DENGAN PENGENDALIAN UKURAN LANGKAH
D  :  SELESAI

PILIHAN ANDA = C
```

| I | X[I] | W[I] | H | T | Y[I] | e relatif |
|---|---|---|---|---|---|---|
| 0 | 0.00000 | 2.0685858794 | 0.25000 | 0.04712051 | 1.0000000000 | |
| 1 | 0.12988 | 1.0080814552 | 0.12988 | 0.00000607 | 1.0080811537 | 0.000030 |
| 2 | 0.25977 | 1.0309984858 | 0.12988 | 0.00000607 | 1.0309979563 | 0.000051 |
| 3 | 0.38965 | 1.0669440985 | 0.12988 | 0.00000607 | 1.0669434010 | 0.000065 |
| 4 | 0.51953 | 1.1143300107 | 0.12988 | 0.00000607 | 1.1143305771 | 0.000051 |
| 5 | 0.64941 | 1.1717643510 | 0.12988 | 0.00000545 | 1.1717658628 | 0.000051 |
| 6 | 0.77930 | 1.2380231651 | 0.12988 | 0.00000466 | 1.2380253812 | 0.000051 |
| 7 | 0.90918 | 1.3120315958 | 0.12988 | 0.00000414 | 1.3120343261 | 0.000051 |

```
Silahkan tekan <ENTER> untuk melanjutkan
```

| I | X[I] | W[I] | H | T | Y[I] | e relatif |
|---|---|---|---|---|---|---|
| 9 | 1.16895 | 1.4796365755 | 0.12988 | 0.00000319 | 1.4796398904 | 0.000051 |
| 10 | 1.29883 | 1.5716761814 | 0.12988 | 0.00000280 | 1.5716796235 | 0.000051 |
| 11 | 1.42871 | 1.6683252206 | 0.12988 | 0.00000246 | 1.6683287097 | 0.000051 |
| 12 | 1.55859 | 1.7690222483 | 0.12988 | 0.00000216 | 1.7690257220 | 0.000051 |
| 13 | 1.68848 | 1.8732742060 | 0.12988 | 0.00000190 | 1.8732776162 | 0.000051 |
| 14 | 1.81836 | 1.9806480910 | 0.12988 | 0.00000167 | 1.9806514017 | 0.000051 |
| 15 | 1.94824 | 2.0907636421 | 0.12988 | 0.00000146 | 2.0907668268 | 0.000051 |

```
ANDA INGIN MENGHITUNG LAGI DENGAN DATA YANG SAMA ? (Y / T) Y
```

```
     MENU PILIHAN ANDA :
A : METODE ADAMS-BASHFORT ORDE 4
B : METODE PREDIKTOR-KOREKTOR ADAMS
C : METODE PREDIKTOR-KOREKTOR ADAMS
    DENGAN PENGENDALIAN UKURAN LANGKAH
D : SELESAI

PILIHAN ANDA = X

PILIHAN ANDA TIDAK TEPAT !!!

ANDA INGIN MENGHITUNG LAGI DENGAN DATA YANG SAMA ? (Y / T) Y



     MENU PILIHAN ANDA :
A : METODE ADAMS-BASHFORT ORDE 4
B : METODE PREDIKTOR-KOREKTOR ADAMS
C : METODE PREDIKTOR-KOREKTOR ADAMS
    DENGAN PENGENDALIAN UKURAN LANGKAH
D : SELESAI

PILIHAN ANDA = D
```

TERIMA KASIH ATAS PERHATIAN ANDA