Chapter 10
Control Break Logic

Objectives

Upon completion of this chapter you will be able to:
- Describe the write, roll, zero, and save steps used in control break processing,
- Design and code a program using single level control break processing,
- Design and code a program using multiple level control break processing, and
- Design and code a program using control break processing to produce a summary report.

Introduction

In each of our programs thus far any counts and/or totals were shown at end of job only. In this chapter we will learn to produce **subtotals** as well. Subtotals can be done at any number of levels, and are the result of **control break processing**. In this chapter we will introduce single level and multiple level control break processing. No new instructions are introduced in this chapter.

Throughout this chapter we will make use of the course offerings file, `OFFER.DAT`. Our first program, `OFFER10A.MLC`, lists selected fields from each record in that file. Page break logic is included. There is a limit of ten detail lines per page. The output is shown below, and the complete program listing is found on the next page. There is nothing new here: the program is given so as to provide a starting point for our discussion.

```
________________________________________
          COURSE OFFERINGS      Page   1

   Sem   Course   Section   Teacher
   ---   ------   -------   -------
   W92    EG102      1        732
   W92    MA107      1        218
   W92    PE151      1        574
   F92    AC101      1        218
   F92    BU101      1        218
   F92    EG101      1        732
   F92    EG101      2        732
   F92    MA101      1        626
   F92    MA101      2        626
   F92    PE151      1        574
________________________________________
          COURSE OFFERINGS      Page   2

   Sem   Course   Section   Teacher
   ---   ------   -------   -------
   W93    EG102      1        854
   W93    MA101      1        626
   W93    MA107      1        626
   W93    PE151      1        574
```

```
         PRINT NOGEN
****************************************************************
*        FILENAME:  OFFER10A.MLC                               *
*        AUTHOR  :  Bill Qualls                                *
*        SYSTEM  :  PC/370 R4.2                                *
*        REMARKS :  Produce list of course offerings for all   *
*                   semesters. Includes page break logic.      *
****************************************************************
         START 0
         REGS
BEGIN    BEGIN
         WTO   'OFFER10A ... Begin execution'
         BAL   R10,SETUP
MAIN     EQU   *
         CLI   EOFSW,C'Y'
         BE    EOJ
         BAL   R10,PROCESS
         B     MAIN
EOJ      EQU   *
         BAL   R10,WRAPUP
         WTO   'OFFER10A ... Normal end of program'
         RETURN
****************************************************************
*        SETUP - Those things which happen one time only,      *
*                before any records are processed.             *
****************************************************************
SETUP    EQU   *
         ST    R10,SVSETUP
         OI    OFFER+10,X'08'     PC/370 ONLY - Convert all
*                                 input from ASCII to EBCDIC
         OI    REPORT+10,X'08'    PC/370 ONLY - Convert all
*                                 output from EBCDIC to ASCII
         OPEN  OFFER
         OPEN  REPORT
         BAL   R10,READ
         L     R10,SVSETUP
         BR    R10
****************************************************************
*        HDGS - Print headings.                                *
****************************************************************
HDGS     EQU   *
         ST    R10,SVHDGS
         AP    PGS,=P'1'          Add 1 to page count
         MVC   HDPGS,=X'40202120' Edit pattern for page count
         ED    HDPGS,PGS          Move page count to heading
         PUT   REPORT,FORMFEED    PC/370 ONLY
         PUT   REPORT,HD1
         PUT   REPORT,HD2
         PUT   REPORT,HD3
         PUT   REPORT,HD4
         ZAP   LNS,=P'0'          Reset line count to zero
         L     R10,SVHDGS
         BR    R10
****************************************************************
*        PROCESS - Those things which happen once per record.  *
****************************************************************
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKLNS
         BAL   R10,FORMAT
```

(continued)

```
         BAL   R10,WRITE
         BAL   R10,READ
         L     R10,SVPROC
         BR    R10
*****************************************************************
*        READ - Read a record.                                  *
*****************************************************************
READ     EQU   *
         ST    R10,SVREAD
         GET   OFFER,IREC          Read a single offer record
         B     READX
ATEND    EQU   *
         MVI   EOFSW,C'Y'
READX    EQU   *
         L     R10,SVREAD
         BR    R10
*****************************************************************
*        CHKLNS - Check lines printed. Full page?               *
*****************************************************************
CHKLNS   EQU   *
         ST    R10,SVCHKLNS
         CP    LNS,MAXLNS
         BL    CHKLNSX
         BAL   R10,HDGS
CHKLNSX  EQU   *
         L     R10,SVCHKLNS
         BR    R10
*****************************************************************
*        FORMAT - Format a single detail line.                  *
*****************************************************************
FORMAT   EQU   *
         ST    R10,SVFORM
         MVC   OREC(40),BLANKS
         MVC   OSEM,ISEM           Semester
         MVC   OCID,ICID           Course ID
         MVC   OSECT,ISECT         Section number
         MVC   OTID,ITID           Teacher ID
         MVC   OCRLF,WCRLF         PC/370 Only
         L     R10,SVFORM
         BR    R10
*****************************************************************
*        WRITE - Write a single detail line.                    *
*****************************************************************
WRITE    EQU   *
         ST    R10,SVWRITE
         PUT   REPORT,OREC         Write report line
         AP    LNS,=P'1'
         L     R10,SVWRITE
         BR    R10
*****************************************************************
*        WRAPUP - Those things which happen one time only,      *
*                 after all records have been processed.        *
*****************************************************************
WRAPUP   EQU   *
         ST    R10,SVWRAP
         CLOSE OFFER
         CLOSE REPORT
         WTO   'OFFER10A ... Course list on REPORT.TXT'
         L     R10,SVWRAP
         BR    R10
```

(continued)

```
****************************************************************
*        Literals, if any, will go here                        *
***************************************************************
         LTORG
****************************************************************
*        File definitions                                      *
****************************************************************
OFFER    DCB   LRECL=18,RECFM=F,MACRF=G,EODAD=ATEND,
               DDNAME='OFFER.DAT'
REPORT   DCB   LRECL=42,RECFM=F,MACRF=P,
               DDNAME='REPORT.TXT'
****************************************************************
*        RETURN ADDRESSES                                      *
****************************************************************
SVSETUP  DC    F'0'               SETUP
SVHDGS   DC    F'0'               HDGS
SVPROC   DC    F'0'               PROCESS
SVREAD   DC    F'0'               READ
SVFORM   DC    F'0'               FORMAT
SVWRITE  DC    F'0'               WRITE
SVWRAP   DC    F'0'               WRAPUP
SVCHKLNS DC    F'0'               CHKLNS
****************************************************************
*        Miscellaneous field definitions                       *
****************************************************************
WCRLF    DC    X'0D25'            PC/370 ONLY - EBCDIC CR/LF
EOFSW    DC    CL1'N'             End of file? (Y/N)
PGS      DC    PL2'0'             Nbr of pages printed.
LNS      DC    PL2'10'            Lines printed on this page.
MAXLNS   DC    PL2'10'            Max nbr lines per page.
*                                 My line counts exclude hdgs.
BLANKS   DC    CL40' '
****************************************************************
*        Input record definition                               *
****************************************************************
IREC     DS    0CL18      1-18    Offer record
ISEM     DS    CL3        1- 3    Semester
ICID     DS    0CL5       4- 8    Course ID
IDEPT    DS    CL2        4- 5    Department
         DS    CL3        6- 8    Course number
ISECT    DS    CL1        9- 9    Section number
ITID     DS    CL3       10-12    Teacher ID
IROOM    DS    CL4       13-16    Room number
IOCRLF   DS    CL2       17-18    PC/370 only - CR/LF
****************************************************************
*        Output (line) definition                              *
****************************************************************
OREC     DS    0CL42      1-42
         DC    CL3' '     1- 3
OSEM     DS    CL3        4- 6    Semester
         DC    CL4' '     7-10
OCID     DS    CL5       11-15    Course ID
         DC    CL6' '    16-21
OSECT    DS    CL1       22-22    Section number
         DC    CL8' '    23-30
OTID     DS    CL3       31-33    Teacher ID
         DC    CL7' '    34-40
OCRLF    DS    CL2       41-42    PC/370 only - CR/LF
```

(continued)

```
****************************************************************
*        Headings definitions                                  *
****************************************************************
*
*  ----+----1----+----2----+----3----+----4
*            COURSE OFFERINGS      PageBZZ9
*
*     Sem   Course   Section   Teachers
*     ---   ------   -------   --------
*     XXX    XXXXX      X        XXX
*     XXX    XXXXX      X        XXX
*     XXX    XXXXX      X        XXX
*
FORMFEED DS    0CL42              PC/370 only
*        DC    X'0C'              EBCDIC formfeed
*        DC    CL39' '
         DC    40C'_'             For testing...
         DC    X'0D25'            EBCDIC CR/LF
HD1      DS    0CL42
         DC    CL36'          COURSE OFFERINGS      Page'
HDPGS    DC    CL4'BZZ9'
         DC    XL2'0D25'
HD2      DS    0CL42
         DC    CL40' '
         DC    XL2'0D25'
HD3      DS    0CL42
         DC    CL40'   Sem   Course   Section   Teacher     '
         DC    XL2'0D25'
HD4      DS    0CL42
         DC    CL40'   ---   ------   -------   -------     '
         DC    XL2'0D25'
         END   BEGIN
```

Single Level Control Break - Programming Problem

Notice that the above report is in semester sequence. *Let's modify the report so that there is only one semester per page.* Since there will be only one semester per page, it would be redundant to include the semester in the detail lines, so let's drop that column, and show the semester in the headings instead. Also, let's show a count of the number of sections in a semester at the end of each semester. Our new report will appear as follows:

```
________________________________________
          COURSE OFFERINGS      Page   1
            Semester W92                  <--<< Semester
                                                in heading
         Course   Section   Teacher
         ------   -------   -------
          EG102      1        732
          MA107      1        218
          PE151      1        574

      *** Sem W92    3 sections           <--<< Count by
________________________________________        semester
```

(continued)

```
          COURSE OFFERINGS      Page   2
            Semester F92                   <--<< One semester
                                                 per page
         Course   Section   Teacher
         ------   -------   -------
          AC101      1        218
          BU101      1        218
          EG101      1        732
          EG101      2        732
          MA101      1        626
          MA101      2        626
          PE151      1        574

      *** Sem F92    7 sections
________________________________________
          COURSE OFFERINGS      Page   3
            Semester W93

         Course   Section   Teacher
         ------   -------   -------
          EG102      1        854
          MA101      1        626
          MA107      1        626
          PE151      1        574

      *** Sem W93    4 sections
```

Single Level Control Break - Logic

The changes necessary to produce this report is as follows:

1. Check for a change in semester. In order to see if the semester in one record differs from the semester in the previous record, we will need a variable wherein we can "hold" the semester from record to record. This will be defined as:

```
HOLDSEM  DC    CL3' '             Hold semester
```

We said the semester would now be a part of the headings:

```
HD2      DS    0CL42
         DC    CL21'            Semester '
HDSEM    DS    CL3
         DC    CL16' '
         DC    XL2'0D25'
```

...so prior to printing the headings, we will move `HOLDSEM` to `HDSEM`:

```
HDGS     EQU   *
         ST    R10,SVHDGS
         AP    PGS,=P'1'          Add 1 to page count
         MVC   HDPGS,=X'40202120' Edit pattern for page count
         ED    HDPGS,PGS          Move page count to heading
         PUT   REPORT,FORMFEED    PC/370 ONLY
         MVC   HDSEM,HOLDSEM
         PUT   REPORT,HD1
```

Of course, we want the semester from the first record to be recognized as such, otherwise we will try to print totals after having read the first record only. So, we initialize HOLDSEM within the SETUP routine immediately after the priming read:

```
         BAL   R10,READ
         MVC   HOLDSEM,ISEM        Control break
```

As each record is processed, we will check for a change in semester. Since this is a check done for each record, it will, of course, fall within the PROCESS routine (as opposed to SETUP or WRAPUP.) We will invoke a separate routine, CHKSEM, to see if the semester has changed. We do so only to keep the PROCESS routine simple and uncluttered:

```
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKSEM          See if new semester
```

...where CHKSEM is defined as:

```
*****************************************************************
*        CHKSEM - Check for change in semester                  *
*                  (control break)                              *
*****************************************************************
CHKSEM   EQU   *
         ST    R10,SVCHKSEM
         CLC   HOLDSEM,ISEM        Compare w/ current
         BE    CHKSEMX             Same semester, get out
         BAL   R10,ENDSEM          Process semester break
         MVC   HOLDSEM,ISEM        Update control break field
CHKSEMX  EQU   *
         L     R10,SVCHKSEM
         BR    R10
```

Again, this could have been done within PROCESS as follows:

```
PROCESS  EQU   *
         ST    R10,SVPROC
         CLC   HOLDSEM,ISEM        Compare w/ current
         BE    PROCESS2            Same semester, get out
         BAL   R10,ENDSEM          Process semester break
         MVC   HOLDSEM,ISEM        Update control break field
PROCESS2 EQU   *
```
(continued)

Note that having ended one semester and started another, we move the current semester, ISEM, to the control break field, HOLDSEM.

2. <u>If the semester has changed, then end that semester and start another.</u> We see from CHKSEM that if the semester has changed, that is, if HOLDSEM does not equal ISEM, then we invoke the control break routine, ENDSEM. This new routine will (a) print the number of sections for this semester, (b) reset the sections counter to zero, and (c) force the next semester to a new page:

```
ENDSEM   EQU   *
         ST    R10,SVENDSEM
         MVC   OREC(40),BLANKS    This area used several ways
         BAL   R10,WRITE          Skip a line
         MVC   OREC+6(25),=C'*** Sem XXX BZZ9 sections'
         MVC   OREC+14(3),HOLDSEM
         MVC   OREC+18(4),=X'40202120'
         ED    OREC+18(4),#SEM
         BAL   R10,WRITE
         MVC   OREC(40),BLANKS
         ZAP   #SEM,=P'0'         Reset counter
         ZAP   LNS,MAXLNS         Force next sem. to new page
         L     R10,SVENDSEM
         BR    R10
```

2(a) Print the number of sections for this semester. Note how the count is formatted. First, the line is cleared. (This is the same area as was used for the details, but we can reuse it for showing the counts if we like.) Of course, when we move `BLANKS` to `OREC`, we do so for a length of 40 only so as not to destroy the `CR/LF`. Otherwise, we would need to remember to move `X'0D25'` to `OREC+40(2)`. We then move a description of the count. Notice how a long label was used, with `XXX` indicating where the semester will go, and `BZZ9` indicating where the count will go. It is by no means necessary to do it this way. I find this technique to be quite useful in that it is somewhat self-documenting. This is particularly important if we are going to use explicit displacement and length as shown above. Nevertheless, the following is functionally equivalent and probably more commonly used:

```
         MVC   OREC+6(7),=C'*** Sem'
         MVC   OREC+14(3),HOLDSEM
         MVC   OREC+18(4),=X'40202120'
         ED    OREC+18(4),#SEM
         MVC   OREC+23(8),=C'sections'
```

Having used the detail line in this way, we must remember to clean up after ourselves; that is, once again move `BLANKS` to `OREC(40)`.

You might feel uneasy with reusing the detail line as we have done here. It is very common to define a separate record for this purpose:

```
         MVC   TOTSEM,HOLDSEM
         MVC   TOTCOUNT,=X'40202120'
         ED    TOTCOUNT,#SEM
         PUT   REPORT,TOTREC
         AP    LNS,=P'1'
```

where...

```
TOTREC   DS    0CL42
         DC    CL6' '
         DC    CL8'*** SEM '
TOTSEM   DC    CL3' '
         DC    CL1' '
TOTCOUNT DC    CL4' '
         DC    CL18' sections'
         DC    X'0D25'   CR/LF
```

Note that we use PUT REPORT,TOTREC and increment the line counter here rather than BAL R10,WRITE because that (WRITE) routine puts OREC (only) to REPORT.

2(b) Reset the sections counter to zero. We move zero to the counter for number of sections within this semester, #SEM. Otherwise, the sections count for semester W92 will be included in the sections count for semester F93, and the sections count for semesters W92 *and* F93 will be included in the sections count for semester W93.

2(c) Force the next semester to a new page. Forcing each new semester to a new page is simple: just set the line counter to the maximum allowed. Recall that before printing any detail lines, we always invoke the CHKLNS routine to see if a page is full and, if so, print the headings. By setting the line counter to the maximum allowed, the page will be considered full and headings will be printed, with the new semester, prior to printing the next detail line.

3. As each record is processed, add one to the number of sections for that semester. This is done for each record and, as such, is included in the PROCESS routine. It is done after the check for a new semester, otherwise the wrong semester may get "credit" for this record.

```
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKSEM          See if new semester
         AP    #SEM,=P'1'          Count sections by semester
```

4. After all records have been processed, print one last set of totals. Within the WRAPUP routine we invoke the control break routine one last time: not because a new semester has begun, but because the last semester has ended. If we fail to do so, then we will not get a count of sections for the last semester.

```
WRAPUP   EQU   *
         ST    R10,SVWRAP
         BAL   R10,ENDSEM          Final control break process
         CLOSE OFFER
         CLOSE REPORT
```

This can be done before or after closing the OFFER file, but *must* be done *before* closing the REPORT file.

Single Level Control Break - Program Solution

```
         PRINT NOGEN
****************************************************************
*        FILENAME:  OFFER10B.MLC                               *
*        AUTHOR  :  Bill Qualls                                *
*        SYSTEM  :  PC/370 R4.2                                *
*        REMARKS :  Produce list of course offerings for all   *
*                   semesters. Includes page break logic.      *
*                   Single level control break example.        *
****************************************************************
         START 0
         REGS
BEGIN    BEGIN
         WTO   'OFFER10B ... Begin execution'
         BAL   R10,SETUP
MAIN     EQU   *
         CLI   EOFSW,C'Y'
         BE    EOJ
         BAL   R10,PROCESS
         B     MAIN
EOJ      EQU   *
         BAL   R10,WRAPUP
         WTO   'OFFER10B ... Normal end of program'
         RETURN
****************************************************************
*        SETUP - Those things which happen one time only,      *
*               before any records are processed.             *
****************************************************************
SETUP    EQU   *
         ST    R10,SVSETUP
         OI    OFFER+10,X'08'      PC/370 ONLY - Convert all
*                                  input from ASCII to EBCDIC
         OI    REPORT+10,X'08'     PC/370 ONLY - Convert all
*                                  output from EBCDIC to ASCII
         OPEN  OFFER
         OPEN  REPORT
         BAL   R10,READ
         MVC   HOLDSEM,ISEM        Control break
         L     R10,SVSETUP
         BR    R10
****************************************************************
*        HDGS - Print headings.                                *
****************************************************************
HDGS     EQU   *
         ST    R10,SVHDGS
         AP    PGS,=P'1'           Add 1 to page count
         MVC   HDPGS,=X'40202120'  Edit pattern for page count
         ED    HDPGS,PGS           Move page count to heading
         PUT   REPORT,FORMFEED     PC/370 ONLY
         MVC   HDSEM,HOLDSEM
         PUT   REPORT,HD1
         PUT   REPORT,HD2
         PUT   REPORT,HD3
         PUT   REPORT,HD4
         PUT   REPORT,HD5
         ZAP   LNS,=P'0'           Reset line count to zero
         L     R10,SVHDGS
         BR    R10
```

(continued)

```
****************************************************************
*        PROCESS - Those things which happen once per record.  *
****************************************************************
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKSEM         See if new semester
         AP    #SEM,=P'1'         Count sections by semester
         BAL   R10,CHKLNS
         BAL   R10,FORMAT
         BAL   R10,WRITE
         BAL   R10,READ
         L     R10,SVPROC
         BR    R10
****************************************************************
*        READ - Read a record.                                 *
****************************************************************
READ     EQU   *
         ST    R10,SVREAD
         GET   OFFER,IREC         Read a single offer record
         B     READX
ATEND    EQU   *
         MVI   EOFSW,C'Y'
READX    EQU   *
         L     R10,SVREAD
         BR    R10
****************************************************************
*        CHKSEM - Check for change in semester                 *
*                 (control break)                              *
****************************************************************
CHKSEM   EQU   *
         ST    R10,SVCHKSEM
         CLC   HOLDSEM,ISEM       Compare w/ current
         BE    CHKSEMX            Same semester, get out
         BAL   R10,ENDSEM         Process semester break
         MVC   HOLDSEM,ISEM       Update control break field
CHKSEMX  EQU   *
         L     R10,SVCHKSEM
         BR    R10
****************************************************************
*        ENDSEM - End semester                                 *
*                 (Process control break)                      *
*                 Show count of sections for this semester.    *
*                 Force next semester to another page.         *
****************************************************************
ENDSEM   EQU   *
         ST    R10,SVENDSEM
         MVC   OREC(40),BLANKS    This area used several ways
         BAL   R10,WRITE          Skip a line
         MVC   OREC+6(25),=C'*** Sem XXX BZZ9 sections'
         MVC   OREC+14(3),HOLDSEM
         MVC   OREC+18(4),=X'40202120'
         ED    OREC+18(4),#SEM
         BAL   R10,WRITE
         MVC   OREC(40),BLANKS
         ZAP   #SEM,=P'0'         Reset counter
         ZAP   LNS,MAXLNS         Force next sem. to new page
         L     R10,SVENDSEM
         BR    R10
```

(continued)

```
*****************************************************************
*        CHKLNS - Check lines printed. Full page?               *
*****************************************************************
CHKLNS   EQU   *
         ST    R10,SVCHKLNS
         CP    LNS,MAXLNS
         BL    CHKLNSX
         BAL   R10,HDGS
CHKLNSX  EQU   *
         L     R10,SVCHKLNS
         BR    R10
*****************************************************************
*        FORMAT - Format a single detail line.                  *
*****************************************************************
FORMAT   EQU   *
         ST    R10,SVFORM
         MVC   OREC(40),BLANKS     Removed MVC OSEM,ISEM
         MVC   OCID,ICID           Course ID
         MVC   OSECT,ISECT         Section number
         MVC   OTID,ITID           Teacher ID
         MVC   OCRLF,WCRLF         PC/370 Only
         L     R10,SVFORM
         BR    R10
*****************************************************************
*        WRITE - Write a single detail line.                    *
*****************************************************************
WRITE    EQU   *
         ST    R10,SVWRITE
         PUT   REPORT,OREC         Write report line
         AP    LNS,=P'1'
         L     R10,SVWRITE
         BR    R10
*****************************************************************
*        WRAPUP - Those things which happen one time only,      *
*                 after all records have been processed.        *
*****************************************************************
WRAPUP   EQU   *
         ST    R10,SVWRAP
         BAL   R10,ENDSEM          Final control break process
         CLOSE OFFER
         CLOSE REPORT
         WTO   'OFFER10B ... Course list on REPORT.TXT'
         L     R10,SVWRAP
         BR    R10
*****************************************************************
*        Literals, if any, will go here                         *
****************************************************************
         LTORG
*****************************************************************
*        File definitions                                       *
*****************************************************************
OFFER    DCB   LRECL=18,RECFM=F,MACRF=G,EODAD=ATEND,
               DDNAME='OFFER.DAT'
REPORT   DCB   LRECL=42,RECFM=F,MACRF=P,
               DDNAME='REPORT.TXT'
*****************************************************************
*        RETURN ADDRESSES                                       *
*****************************************************************
SVSETUP  DC    F'0'                SETUP
SVHDGS   DC    F'0'                HDGS
```

(continued)

```
SVPROC   DC    F'0'               PROCESS
SVREAD   DC    F'0'               READ
SVFORM   DC    F'0'               FORMAT
SVWRITE  DC    F'0'               WRITE
SVWRAP   DC    F'0'               WRAPUP
SVCHKLNS DC    F'0'               CHKLNS
SVCHKSEM DC    F'0'               CHKSEM
SVENDSEM DC    F'0'               ENDSEM
****************************************************************
*        Miscellaneous field definitions                       *
****************************************************************
WCRLF    DC    X'0D25'            PC/370 ONLY - EBCDIC CR/LF
EOFSW    DC    CL1'N'             End of file? (Y/N)
PGS      DC    PL2'0'             Nbr of pages printed.
LNS      DC    PL2'10'            Lines printed on this page.
MAXLNS   DC    PL2'10'            Max nbr lines per page.
*                                 My line counts exclude hdgs.
BLANKS   DC    CL40' '
HOLDSEM  DC    CL3' '             Hold semester
#SEM     DC    PL2'0'             Sections in a semester
****************************************************************
*        Input record definition                               *
****************************************************************
IREC     DS    0CL18      1-18    Offer record
ISEM     DS    CL3        1- 3    Semester
ICID     DS    0CL5       4- 8    Course ID
IDEPT    DS    CL2        4- 5    Department
         DS    CL3        6- 8    Course number
ISECT    DS    CL1        9- 9    Section number
ITID     DS    CL3       10-12    Teacher ID
IROOM    DS    CL4       13-16    Room number
IOCRLF   DS    CL2       17-18    PC/370 only - CR/LF
****************************************************************
*        Output (line) definition                              *
****************************************************************
OREC     DS    0CL42      1-42
         DC    CL10' '    1-10
OCID     DS    CL5       11-15    Course ID
         DC    CL6' '    16-21
OSECT    DS    CL1       22-22    Section number
         DC    CL8' '    23-30
OTID     DS    CL3       31-33    Teacher ID
         DC    CL7' '    34-40
OCRLF    DS    CL2       41-42    PC/370 only - CR/LF
****************************************************************
*        Headings definitions                                  *
****************************************************************
*
*  ----+----1----+----2----+----3----+----4
*            COURSE OFFERINGS      PageBZZ9
*              Semester XXX
*
*           Course   Section   Teachers
*           ------   -------   --------
*            XXXXX      X        XXX
*            XXXXX      X        XXX
*            XXXXX      X        XXX
*
*            Sem XXX BZZ9 sections
*
```

(continued)

```
FORMFEED DS    0CL42              PC/370 only
*        DC    X'0C'              EBCDIC formfeed
*        DC    CL39' '
         DC    40C'_'             For testing...
         DC    X'0D25'            EBCDIC CR/LF
HD1      DS    0CL42
         DC    CL36'          COURSE OFFERINGS      Page'
HDPGS    DC    CL4'BZZ9'
         DC    XL2'0D25'
HD2      DS    0CL42
         DC    CL21'            Semester '
HDSEM    DS    CL3
         DC    CL16' '
         DC    XL2'0D25'
HD3      DS    0CL42
         DC    CL40' '
         DC    XL2'0D25'
HD4      DS    0CL42
         DC    CL40'         Course   Section   Teacher     '
         DC    XL2'0D25'
HD5      DS    0CL42
         DC    CL40'         ------   -------   -------     '
         DC    XL2'0D25'
         END   BEGIN
```

Multiple Level Control Break - Programming Problem

We now introduce ***multiple level control break*** processing. Let's assume that, in addition to showing a count of sections by semester, we would also like to show a count of sections *by department within semester*; for example, after listing all sections offered by the Math department, we will show a count of those sections. We will, however, show this count only if the count is greater than 1, so as not to clutter our report. Furthermore, we will always double space (skip a line) between departments. Our new report will appear as shown on the next page.

Multiple Level Control Break - Logic

The logic necessary to produce this report is similar to that used in single level control break processing and is as follows:

1. Check for a change in department. Just as we checked for a change in semester in the previous program, we need to check for a change in department in this program. In order to do so, we will need a variable wherein we can "hold" the department from record to record. This will be defined as:

```
HOLDDEPT DC    CL2' '             Hold department
```

Of course, we want the semester *and* department from the first record to be recognized as such, so we initialize `HOLDSEM` *and* `HOLDDEPT` within the `SETUP` routine after the priming read:

Output from OFFER10C.MLC - Multiple Level Control Break Example

```
________________________________________
          COURSE OFFERINGS      Page   1
            Semester W92

         Course   Section   Teacher
         ------   -------   -------
          EG102      1        732

          MA107      1        218

          PE151      1        574

      *** Sem W92    3 sections
________________________________________
          COURSE OFFERINGS      Page   2
            Semester F92

         Course   Section   Teacher
         ------   -------   -------
          AC101      1        218

          BU101      1        218

          EG101      1        732
          EG101      2        732

       ** Dept EG    2 sections

          MA101      1        626
________________________________________
          COURSE OFFERINGS      Page   3
            Semester F92

         Course   Section   Teacher
         ------   -------   -------
          MA101      2        626

       ** Dept MA    2 sections

          PE151      1        574

      *** Sem F92    7 sections
________________________________________
          COURSE OFFERINGS      Page   4
            Semester W93

         Course   Section   Teacher
         ------   -------   -------
          EG102      1        854

          MA101      1        626
          MA107      1        626

       ** Dept MA    2 sections

          PE151      1        574

      *** Sem W93    4 sections
```

Note that semester F92 "spans" two pages.

```
         BAL   R10,READ
         MVC   HOLDSEM,ISEM       Major control break
         MVC   HOLDDEPT,IDEPT     Minor control break
```

As each record is processed, we will check for a change in semester *or* department. Since this is a check done for each record, it will fall within the `PROCESS` routine. We will invoke `CHKSEM` to see if the semester has changed, and invoke `CHKDEPT` to see if the department has changed.

It is important to note that a change in semester implies a change in department. For example, if the last department listed in semester `W92` was `PE`, and the first department listed in semester `F93` was also `PE`, then these would appear on two separate pages and have two separate counts. *So we check the semester before checking the department:*

```
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKSEM         See if new semester
         BAL   R10,CHKDEPT        See if new department
```

where `CHKSEM` and `CHKDEPT` are...

```
****************************************************************
*        CHKSEM - Check for change in semester                 *
*                 (major control break)                        *
****************************************************************
CHKSEM   EQU   *
         ST    R10,SVCHKSEM
         CLC   HOLDSEM,ISEM       Compare w/ current
         BE    CHKSEMX            Same semester, get out
         BAL   R10,ENDSEM         Process semester break
         MVC   HOLDSEM,ISEM       Update major break field
         MVC   HOLDDEPT,IDEPT     Update minor break field
CHKSEMX  EQU   *
         L     R10,SVCHKSEM
         BR    R10
****************************************************************
*        CHKDEPT - Check for change in department              *
*                  (minor control break)                       *
****************************************************************
CHKDEPT  EQU   *
         ST    R10,SVCHKDEP
         CLC   HOLDDEPT,IDEPT     Compare w/ current
         BE    CHKDEPTX           Same department, get out
         BAL   R10,ENDDEPT        Process department break
         MVC   HOLDDEPT,IDEPT     Update control break field
CHKDEPTX EQU   *
         L     R10,SVCHKDEP
         BR    R10
```

In multiple level control break processing, always evaluate the control break fields from major to minor!

2. If the semester has changed, then end that semester and start another. The processing here is the same as in the previous program except *a change in semester implies a change in department*. So the first thing we do within ENDSEM is end the previous department and begin the next department:

```
ENDSEM   EQU   *
         ST    R10,SVENDSEM
         BAL   R10,ENDDEPT        Change in semester implies
*                                 change in department as well.
         MVC   OREC(40),BLANKS    This area used several ways
         MVC   OREC+6(25),=C'*** Sem XXX BZZ9 sections'
```

(ENDDEPT is discussed below.)

> *In multiple level control break processing, a break at one level implies a break at all lower levels!*

3. If the department has changed, then end that department and start another. We see from CHKDEPT that if the department has changed, that is, if HOLDDEPT does not equal IDEPT, then we invoke the control break routine, ENDDEPT. This new routine will (a) print the number of sections for this department (if two or more according to the specifications given above), (b) print a blank line (regardless of the number of sections for this department), and (c) reset the department-level sections counter to zero:

```
****************************************************************
*        ENDDEPT- End department                               *
*                 (Process minor control break)                *
*                 Print count of sections in department        *
*                 if that count is two or more.                *
*                 Regardless, skip a line.                     *
****************************************************************
ENDDEPT  EQU   *
         ST    R10,SVENDDEP
         CP    #DEPT,=P'2'
         BL    ENDDEPT2
         MVC   OREC(40),BLANKS    This area used several ways
         BAL   R10,WRITE          Blank line before count
         MVC   OREC+7(24),=C'** Dept XX BZZ9 sections'
         MVC   OREC+15(2),HOLDDEPT
         MVC   OREC+18(4),=X'40202120'
         ED    OREC+18(4),#DEPT
         BAL   R10,WRITE
ENDDEPT2 EQU   *
         MVC   OREC(40),BLANKS
         BAL   R10,WRITE
         ZAP   #DEPT,=P'0'        Reset counter
         L     R10,SVENDDEP
         BR    R10
```

If we wanted a count by department, whether or not that count was greater than one, then we need only remove the CP and BL instructions. (This section will not be discussed in detail as the reasoning is similar to that used in the discussion of ENDSEM in the previous program.)

4. As each record is processed, add one to the number of sections for that semester and department. This is done for each record and, as such, is included in the PROCESS routine. It is done after the check for a new semester or new department.

```
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKSEM          See if new semester
         BAL   R10,CHKDEPT         See if new department
         AP    #SEM,=P'1'          Count sections by semester
         AP    #DEPT,=P'1'         Count sections by department
```

5. After all records have been processed, print one last set of totals. Within the WRAPUP routine we invoke ENDSEM one last time, just as in the previous program. Note that we do not need to invoke ENDDEPT, since ENDSEM will do that. Therefore, we will get totals for the last department (if more than 1 section was offered), as well as totals for the last semester. The routine is the same as in the previous program:

```
WRAPUP   EQU   *
         ST    R10,SVWRAP
         BAL   R10,ENDSEM          Final control break process
         CLOSE OFFER
         CLOSE REPORT
```

Multiple Level Control Break - Program Solution

```
         PRINT NOGEN
****************************************************************
*        FILENAME:  OFFER10C.MLC                               *
*        AUTHOR  :  Bill Qualls                                *
*        SYSTEM  :  PC/370 R4.2                                *
*        REMARKS :  Produce list of course offerings for all   *
*                   semesters. Includes page break logic.      *
*                   Multiple level control break example.      *
****************************************************************
         START 0
         REGS
BEGIN    BEGIN
         WTO   'OFFER10C ... Begin execution'
         BAL   R10,SETUP
MAIN     EQU   *
         CLI   EOFSW,C'Y'
         BE    EOJ
         BAL   R10,PROCESS
         B     MAIN
```

(continued)

```
EOJ      EQU   *
         BAL   R10,WRAPUP
         WTO   'OFFER10C ... Normal end of program'
         RETURN
****************************************************************
*        SETUP - Those things which happen one time only,      *
*               before any records are processed.             *
****************************************************************
SETUP    EQU   *
         ST    R10,SVSETUP
         OI    OFFER+10,X'08'     PC/370 ONLY - Convert all
*                                 input from ASCII to EBCDIC
         OI    REPORT+10,X'08'    PC/370 ONLY - Convert all
*                                 output from EBCDIC to ASCII
         OPEN  OFFER
         OPEN  REPORT
         BAL   R10,READ
         MVC   HOLDSEM,ISEM       Major control break
         MVC   HOLDDEPT,IDEPT     Minor control break
         L     R10,SVSETUP
         BR    R10
****************************************************************
*        HDGS - Print headings.                                *
****************************************************************
HDGS     EQU   *
         ST    R10,SVHDGS
         AP    PGS,=P'1'          Add 1 to page count
         MVC   HDPGS,=X'40202120' Edit pattern for page count
         ED    HDPGS,PGS          Move page count to heading
         PUT   REPORT,FORMFEED    PC/370 ONLY
         MVC   HDSEM,HOLDSEM
         PUT   REPORT,HD1
         PUT   REPORT,HD2
         PUT   REPORT,HD3
         PUT   REPORT,HD4
         PUT   REPORT,HD5
         ZAP   LNS,=P'0'          Reset line count to zero
         L     R10,SVHDGS
         BR    R10
****************************************************************
*        PROCESS - Those things which happen once per record.  *
****************************************************************
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKSEM         See if new semester
         BAL   R10,CHKDEPT        See if new department
         AP    #SEM,=P'1'         Count sections by semester
         AP    #DEPT,=P'1'        Count sections by department
         BAL   R10,CHKLNS
         BAL   R10,FORMAT
         BAL   R10,WRITE
         BAL   R10,READ
         L     R10,SVPROC
         BR    R10
****************************************************************
*        READ - Read a record.                                 *
****************************************************************
READ     EQU   *
         ST    R10,SVREAD
         GET   OFFER,IREC         Read a single offer record
         B     READX
```

(continued)

```
ATEND    EQU   *
         MVI   EOFSW,C'Y'
READX    EQU   *
         L     R10,SVREAD
         BR    R10
****************************************************************
*        CHKSEM - Check for change in semester                 *
*                 (major control break)                        *
****************************************************************
CHKSEM   EQU   *
         ST    R10,SVCHKSEM
         CLC   HOLDSEM,ISEM       Compare w/ current
         BE    CHKSEMX            Same semester, get out
         BAL   R10,ENDSEM         Process semester break
         MVC   HOLDSEM,ISEM       Update major break field
         MVC   HOLDDEPT,IDEPT     Update minor break field
CHKSEMX  EQU   *
         L     R10,SVCHKSEM
         BR    R10
****************************************************************
*        CHKDEPT - Check for change in department              *
*                  (minor control break)                       *
****************************************************************
CHKDEPT  EQU   *
         ST    R10,SVCHKDEP
         CLC   HOLDDEPT,IDEPT     Compare w/ current
         BE    CHKDEPTX           Same department, get out
         BAL   R10,ENDDEPT        Process department break
         MVC   HOLDDEPT,IDEPT     Update control break field
CHKDEPTX EQU   *
         L     R10,SVCHKDEP
         BR    R10
****************************************************************
*        ENDSEM - End semester                                 *
*                 (Process major control break)                *
*                 Show count of sections for this semester.    *
*                 Force next semester to another page.         *
****************************************************************
ENDSEM   EQU   *
         ST    R10,SVENDSEM
         BAL   R10,ENDDEPT        Change in semester implies
*                                 change in department as well.
         MVC   OREC(40),BLANKS    This area used several ways
         MVC   OREC+6(25),=C'*** Sem XXX BZZ9 sections'
         MVC   OREC+14(3),HOLDSEM
         MVC   OREC+18(4),=X'40202120'
         ED    OREC+18(4),#SEM
         BAL   R10,WRITE
         MVC   OREC(40),BLANKS
         ZAP   #SEM,=P'0'         Reset counter
         ZAP   LNS,MAXLNS         Force next sem. to new page
         L     R10,SVENDSEM
         BR    R10
****************************************************************
*        ENDDEPT- End department                               *
*                 (Process minor control break)                *
*                 Print count of sections in department        *
*                 if that count is two or more.                *
*                 Regardless, skip a line.                     *
****************************************************************
```

(continued)

```
ENDDEPT  EQU   *
         ST    R10,SVENDDEP
         CP    #DEPT,=P'2'
         BL    ENDDEPT2
         MVC   OREC(40),BLANKS    This area used several ways
         BAL   R10,WRITE          Blank line before count
         MVC   OREC+7(24),=C'** Dept XX BZZ9 sections'
         MVC   OREC+15(2),HOLDDEPT
         MVC   OREC+18(4),=X'40202120'
         ED    OREC+18(4),#DEPT
         BAL   R10,WRITE
ENDDEPT2 EQU   *
         MVC   OREC(40),BLANKS
         BAL   R10,WRITE
         ZAP   #DEPT,=P'0'        Reset counter
         L     R10,SVENDDEP
         BR    R10
****************************************************************
*        CHKLNS - Check lines printed. Full page?              *
****************************************************************
CHKLNS   EQU   *
         ST    R10,SVCHKLNS
         CP    LNS,MAXLNS
         BL    CHKLNSX
         BAL   R10,HDGS
CHKLNSX  EQU   *
         L     R10,SVCHKLNS
         BR    R10
****************************************************************
*        FORMAT - Format a single detail line.                 *
****************************************************************
FORMAT   EQU   *
         ST    R10,SVFORM
         MVC   OREC(40),BLANKS
         MVC   OCID,ICID          Course ID
         MVC   OSECT,ISECT        Section number
         MVC   OTID,ITID          Teacher ID
         MVC   OCRLF,WCRLF        PC/370 Only
         L     R10,SVFORM
         BR    R10
****************************************************************
*        WRITE - Write a single detail line.                   *
****************************************************************
WRITE    EQU   *
         ST    R10,SVWRITE
         PUT   REPORT,OREC        Write report line
         AP    LNS,=P'1'
         L     R10,SVWRITE
         BR    R10
****************************************************************
*        WRAPUP - Those things which happen one time only,     *
*                 after all records have been processed.       *
****************************************************************
WRAPUP   EQU   *
         ST    R10,SVWRAP
         BAL   R10,ENDSEM         Final control break process
         CLOSE OFFER
         CLOSE REPORT
         WTO   'OFFER10C ... Course list on REPORT.TXT'
```

(continued)

```
         L     R10,SVWRAP
         BR    R10
*****************************************************************
*        Literals, if any, will go here                         *
****************************************************************
         LTORG
*****************************************************************
*        File definitions                                       *
*****************************************************************
OFFER    DCB   LRECL=18,RECFM=F,MACRF=G,EODAD=ATEND,
               DDNAME='OFFER.DAT'
REPORT   DCB   LRECL=42,RECFM=F,MACRF=P,
               DDNAME='REPORT.TXT'
*****************************************************************
*        RETURN ADDRESSES                                       *
*****************************************************************
SVSETUP  DC    F'0'               SETUP
SVHDGS   DC    F'0'               HDGS
SVPROC   DC    F'0'               PROCESS
SVREAD   DC    F'0'               READ
SVFORM   DC    F'0'               FORMAT
SVWRITE  DC    F'0'               WRITE
SVWRAP   DC    F'0'               WRAPUP
SVCHKLNS DC    F'0'               CHKLNS
SVCHKSEM DC    F'0'               CHKSEM
SVCHKDEP DC    F'0'               CHKDEPT
SVENDSEM DC    F'0'               ENDSEM
SVENDDEP DC    F'0'               ENDDEPT
*****************************************************************
*        Miscellaneous field definitions                        *
*****************************************************************
WCRLF    DC    X'0D25'            PC/370 ONLY - EBCDIC CR/LF
EOFSW    DC    CL1'N'             End of file? (Y/N)
PGS      DC    PL2'0'             Nbr of pages printed.
LNS      DC    PL2'10'            Lines printed on this page.
MAXLNS   DC    PL2'10'            Max nbr lines per page.
*                                 My line counts exclude hdgs.
BLANKS   DC    CL40' '
HOLDSEM  DC    CL3' '             Hold semester
HOLDDEPT DC    CL2' '             Hold department
#SEM     DC    PL2'0'             Sections in a semester
#DEPT    DC    PL2'0'             Sections in a semester/dept
*****************************************************************
*        Input record definition                                *
*****************************************************************
IREC     DS    0CL18      1-18    Offer record
ISEM     DS    CL3        1- 3    Semester
ICID     DS    0CL5       4- 8    Course ID
IDEPT    DS    CL2        4- 5    Department
         DS    CL3        6- 8    Course number
ISECT    DS    CL1        9- 9    Section number
ITID     DS    CL3       10-12    Teacher ID
IROOM    DS    CL4       13-16    Room number
IOCRLF   DS    CL2       17-18    PC/370 only - CR/LF
*****************************************************************
*        Output (line) definition                               *
*****************************************************************
OREC     DS    0CL42      1-42
         DC    CL10' '    1-10
OCID     DS    CL5       11-15    Course ID
```

(continued)

```
         DC    CL6' '    16-21
OSECT    DS    CL1       22-22    Section number
         DC    CL8' '    23-30
OTID     DS    CL3       31-33    Teacher ID
         DC    CL7' '    34-40
OCRLF    DS    CL2       41-42    PC/370 only - CR/LF
****************************************************************
*        Headings definitions                                  *
****************************************************************
*
*  ----+----1----+----2----+----3----+----4
*            COURSE OFFERINGS      PageBZZ9
*              Semester XXX
*
*           Course   Section   Teachers
*           ------   -------   --------
*            XXXXX      X        XXX
*
*            XXXXX      X        XXX
*            XXXXX      X        XXX
*
*            Dept XX BZZ9 sections
*
*            Sem XXX BZZ9 sections
*
FORMFEED DS    0CL42              PC/370 only
*        DC    X'0C'              EBCDIC formfeed
*        DC    CL39' '
         DC    40C'_'             For testing...
         DC    X'0D25'            EBCDIC CR/LF
HD1      DS    0CL42
         DC    CL36'          COURSE OFFERINGS      Page'
HDPGS    DC    CL4'BZZ9'
         DC    XL2'0D25'
HD2      DS    0CL42
         DC    CL21'            Semester '
HDSEM    DS    CL3
         DC    CL16' '
         DC    XL2'0D25'
HD3      DS    0CL42
         DC    CL40' '
         DC    XL2'0D25'
HD4      DS    0CL42
         DC    CL40'         Course   Section   Teacher     '
         DC    XL2'0D25'
HD5      DS    0CL42
         DC    CL40'         ------   -------   -------     '
         DC    XL2'0D25'
         END   BEGIN
```

Rolling Totals

There is more than one way to keep the count of sections by department *and* by semester. In our solution we added one to each of these two counters in the PROCESS routine. It is also common to increment the minor counter only (the minor counter is, in this case, the count of sections by department, #DEPT). Then, when a minor control break is detected, add the minor count to the major count, before resetting the minor count to zero. This is sometimes referred to as "rolling" the totals. The implementation of this "rolling" logic would be as follows:

```
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKSEM
         BAL   R10,CHKDEPT          Have removed AP #SEM,=P'1'
         AP    #DEPT,=P'1'
```

and...

```
ENDDEPT  EQU   *
         .
         .
         .
         BAL   R10,WRITE
         AP    #SEM,#DEPT          Roll counts
         ZAP   #DEPT,=P'0'         Reset counter
         L     R10,SVENDDEP
         BR    R10
```

This technique is actually more efficient than the previous method. There are a total of two APs, so the program size is this same. But in the old method, #SEM is incremented (by one) once for each record. In this method, #SEM is incremented (by the amount in #DEPT) *once for each department*. The technique to be used is a matter of personal preference, but you should certainly be able to recognize and understand both.

Summary Report - Programming Problem

In our final version of the program we wish to produce a *summary* report only; that is, rather than list each course and section offered during a given semester, we will show each department and the number of sections offered by that department. Our new report will appear as follows:

```
          COURSE OFFERINGS      Page   1
            Semester W92

          Dept    Sections
         ------   --------
          EG          1
          MA          1
          PE          1
         ------   --------
          Total       3
________________________________________
          COURSE OFFERINGS      Page   2
            Semester F92

          Dept    Sections
         ------   --------
          AC          1
          BU          1
          EG          2
          MA          2
          PE          1
         ------   --------
          Total       7
```

(continued)

```
________________________________________
          COURSE OFFERINGS      Page   3
            Semester W93

          Dept    Sections
         ------   --------
          EG          1
          MA          2
          PE          1
         ------   --------
          Total       4
```

Summary Report - Logic

Though this report differs considerably from the previous report, the changes necessary to produce this report are really quite trivial. First, there is no record level reporting, so the branch-and-link to the FORMAT and WRITE routines have been removed from the PROCESS routine. In fact, the FORMAT routine has been removed from the program entirely. Second, the format of the counts has been changed in the ENDSEM and ENDDEPT routines. All other changes are for formatting purposes only.

Summary Report - Program Solution

```
         PRINT NOGEN
****************************************************************
*        FILENAME:  OFFER10D.MLC                               *
*        AUTHOR  :  Bill Qualls                                *
*        SYSTEM  :  PC/370 R4.2                                *
*        REMARKS :  Produce list of course offerings for all   *
*                   semesters. Includes page break logic.      *
*                   Multiple level control break.              *
*                   Minor break (dept) is summary only.        *
****************************************************************
         START 0
         REGS
BEGIN    BEGIN
         WTO   'OFFER10D ... Begin execution'
         BAL   R10,SETUP
MAIN     EQU   *
         CLI   EOFSW,C'Y'
         BE    EOJ
         BAL   R10,PROCESS
         B     MAIN
EOJ      EQU   *
         BAL   R10,WRAPUP
         WTO   'OFFER10D ... Normal end of program'
         RETURN
****************************************************************
*        SETUP - Those things which happen one time only,      *
*                before any records are processed.             *
****************************************************************
SETUP    EQU   *
         ST    R10,SVSETUP
         OI    OFFER+10,X'08'      PC/370 ONLY - Convert all
*                                  input from ASCII to EBCDIC
```

(continued)

```
         OI    REPORT+10,X'08'    PC/370 ONLY - Convert all
*                                 output from EBCDIC to ASCII
         OPEN  OFFER
         OPEN  REPORT
         BAL   R10,READ
         MVC   HOLDSEM,ISEM       Major control break
         MVC   HOLDDEPT,IDEPT     Minor control break
         L     R10,SVSETUP
         BR    R10
****************************************************************
*        HDGS - Print headings.                                 *
****************************************************************
HDGS     EQU   *
         ST    R10,SVHDGS
         AP    PGS,=P'1'          Add 1 to page count
         MVC   HDPGS,=X'40202120' Edit pattern for page count
         ED    HDPGS,PGS          Move page count to heading
         PUT   REPORT,FORMFEED    PC/370 ONLY
         MVC   HDSEM,HOLDSEM
         PUT   REPORT,HD1
         PUT   REPORT,HD2
         PUT   REPORT,HD3
         PUT   REPORT,HD4
         PUT   REPORT,HD5
         ZAP   LNS,=P'0'          Reset line count to zero
         L     R10,SVHDGS
         BR    R10
****************************************************************
*        PROCESS - Those things which happen once per record.  *
****************************************************************
PROCESS  EQU   *
         ST    R10,SVPROC
         BAL   R10,CHKSEM         See if new semester
         BAL   R10,CHKDEPT        See if new department
         AP    #SEM,=P'1'         Count be semester
         AP    #DEPT,=P'1'        Count by semester/dept
         BAL   R10,READ           No detail-level reporting
         L     R10,SVPROC         Removed BAL to FORMAT and WRITE
         BR    R10
****************************************************************
*        READ - Read a record.                                  *
****************************************************************
READ     EQU   *
         ST    R10,SVREAD
         GET   OFFER,IREC         Read a single offer record
         B     READX
ATEND    EQU   *
         MVI   EOFSW,C'Y'
READX    EQU   *
         L     R10,SVREAD
         BR    R10
****************************************************************
*        CHKSEM - Check for change in semester                  *
*                 (major control break)                         *
****************************************************************
CHKSEM   EQU   *
         ST    R10,SVCHKSEM
         CLC   HOLDSEM,ISEM       Compare w/ current
         BE    CHKSEMX            Same semester, get out
         BAL   R10,ENDSEM         Process semester break
```

(continued)

```
         MVC   HOLDSEM,ISEM       Update major break field
         MVC   HOLDDEPT,IDEPT     Update minor break field
CHKSEMX  EQU   *
         L     R10,SVCHKSEM
         BR    R10
****************************************************************
*        CHKDEPT - Check for change in department              *
*                  (minor control break)                       *
****************************************************************
CHKDEPT  EQU   *
         ST    R10,SVCHKDEP
         CLC   HOLDDEPT,IDEPT     Compare w/ current
         BE    CHKDEPTX           Same department, get out
         BAL   R10,ENDDEPT        Process department break
         MVC   HOLDDEPT,IDEPT     Update control break field
CHKDEPTX EQU   *
         L     R10,SVCHKDEP
         BR    R10
****************************************************************
*        ENDSEM - End semester                                 *
*                 (Process major control break)                *
*                 Show count of sections for this semester.    *
*                 Force next semester to another page.         *
****************************************************************
ENDSEM   EQU   *
         ST    R10,SVENDSEM
         BAL   R10,ENDDEPT        Change in semester implies
*                                 change in department as well.
         PUT   REPORT,HD5
         AP    LNS,=P'1'
         MVC   OREC(40),BLANKS    Reuse this line
         MVC   ODEPT(5),=CL5'Total'
         MVC   O#DEPT,=X'40202120'
         ED    O#DEPT,#SEM
         BAL   R10,WRITE
         MVC   OREC(40),BLANKS
         ZAP   #SEM,=P'0'         Reset semester record count
         ZAP   LNS,MAXLNS         Force next sem. to new page
         L     R10,SVENDSEM
         BR    R10
****************************************************************
*        ENDDEPT- End department                              *
*                 (Process minor control break)                *
*                 Print a count of courses (sections) in       *
*                 this department.                             *
****************************************************************
ENDDEPT  EQU   *
         ST    R10,SVENDDEP
         BAL   R10,CHKLNS
         MVC   OREC(40),BLANKS
         MVC   ODEPT,HOLDDEPT     Department
         MVC   O#DEPT,=X'40202120'
         ED    O#DEPT,#DEPT       How many this department?
         MVC   OCRLF,WCRLF        PC/370 only
         BAL   R10,WRITE
         ZAP   #DEPT,=P'0'        Reset dept record count
         L     R10,SVENDDEP
         BR    R10
****************************************************************
*        CHKLNS - Check lines printed. Full page?              *
****************************************************************
```

(continued)

```
CHKLNS   EQU   *
         ST    R10,SVCHKLNS
         CP    LNS,MAXLNS
         BL    CHKLNSX
         BAL   R10,HDGS
CHKLNSX  EQU   *
         L     R10,SVCHKLNS
         BR    R10
****************************************************************
*        WRITE - Write a single detail line.                   *
****************************************************************
WRITE    EQU   *
         ST    R10,SVWRITE
         PUT   REPORT,OREC        Write report line
         AP    LNS,=P'1'
         L     R10,SVWRITE
         BR    R10
****************************************************************
*        WRAPUP - Those things which happen one time only,     *
*                 after all records have been processed.       *
****************************************************************
WRAPUP   EQU   *
         ST    R10,SVWRAP
         BAL   R10,ENDSEM         Final control break process
         CLOSE OFFER
         CLOSE REPORT
         WTO   'OFFER10D ... Course list on REPORT.TXT'
         L     R10,SVWRAP
         BR    R10
****************************************************************
*        Literals, if any, will go here                        *
***************************************************************
         LTORG
****************************************************************
*        File definitions                                      *
****************************************************************
OFFER    DCB   LRECL=18,RECFM=F,MACRF=G,EODAD=ATEND,
               DDNAME='OFFER.DAT'
REPORT   DCB   LRECL=42,RECFM=F,MACRF=P,
               DDNAME='REPORT.TXT'
****************************************************************
*        RETURN ADDRESSES                                      *
****************************************************************
SVSETUP  DC    F'0'               SETUP
SVHDGS   DC    F'0'               HDGS
SVPROC   DC    F'0'               PROCESS
SVREAD   DC    F'0'               READ
SVFORM   DC    F'0'               FORMAT
SVWRITE  DC    F'0'               WRITE
SVWRAP   DC    F'0'               WRAPUP
SVCHKLNS DC    F'0'               CHKLNS
SVCHKSEM DC    F'0'               CHKSEM
SVCHKDEP DC    F'0'               CHKDEPT
SVENDSEM DC    F'0'               ENDSEM
SVENDDEP DC    F'0'               ENDDEPT
****************************************************************
*        Miscellaneous field definitions                       *
****************************************************************
WCRLF    DC    X'0D25'            PC/370 ONLY - EBCDIC CR/LF
EOFSW    DC    CL1'N'             End of file? (Y/N)
PGS      DC    PL2'0'             Nbr of pages printed.
```

(continued)

```
LNS      DC    PL2'10'            Lines printed on this page.
MAXLNS   DC    PL2'10'            Max nbr lines per page.
*                                 My line counts exclude hdgs.
BLANKS   DC    CL40' '
HOLDSEM  DC    CL3' '             Hold semester
HOLDDEPT DC    CL2' '             Hold department
#SEM     DC    PL2'0'             Sections in a semester
#DEPT    DC    PL2'0'             Sections in a semester/dept
****************************************************************
*        Input record definition                               *
****************************************************************
IREC     DS    0CL18      1-18    Offer record
ISEM     DS    CL3        1- 3    Semester
ICID     DS    0CL5       4- 8    Course ID
IDEPT    DS    CL2        4- 5    Department
         DS    CL3        6- 8    Course number
ISECT    DS    CL1        9- 9    Section number
ITID     DS    CL3       10-12    Teacher ID
IROOM    DS    CL4       13-16    Room number
IOCRLF   DS    CL2       17-18    PC/370 only - CR/LF
****************************************************************
*        Output (line) definition                              *
****************************************************************
OREC     DS    0CL42      1-42
         DC    CL10' '    1-10
ODEPT    DS    CL2       11-12    Department
         DC    CL7' '    13-19
O#DEPT   DS    CL4       20-23    Number of sections
         DC    CL17' '   24-40
OCRLF    DS    CL2       41-42    PC/370 only - CR/LF
****************************************************************
*        Headings definitions                                  *
****************************************************************
*
*  ----+----1----+----2----+----3----+----4
*            COURSE OFFERINGS      PageBZZ9
*              Semester XXX
*
*            Dept    Sections
*           ------   --------
*            XX       BZZ9
*            XX       BZZ9
*           ------   --------
*            Total    BZZ9
*
FORMFEED DS    0CL42              PC/370 only
*        DC    X'0C'              EBCDIC formfeed
*        DC    CL39' '
         DC    40C'_'             For testing...
         DC    X'0D25'            EBCDIC CR/LF
HD1      DS    0CL42
         DC    CL36'          COURSE OFFERINGS      Page'
HDPGS    DC    CL4'BZZ9'
         DC    XL2'0D25'
HD2      DS    0CL42
         DC    CL21'            Semester '
HDSEM    DS    CL3
         DC    CL16' '
         DC    XL2'0D25'
```

(continued)

```
HD3      DS    0CL42
         DC    CL40' '
         DC    XL2'0D25'
HD4      DS    0CL42
         DC    CL40'          Dept    Sections              '
         DC    XL2'0D25'
HD5      DS    0CL42
         DC    CL40'         ------   --------              '
         DC    XL2'0D25'
         END   BEGIN
```

Exercises

1. True or false.

T F a. In control break processing, the control break field(s) are initialized in SETUP prior to the priming read.
T F b. When multiple level control breaks are used, the control break fields are evaluated minor before major.
T F c. When multiple level control breaks are used, a major break implies a minor break.
T F d. Rather than increment counters at all levels within PROCESS, the major totals can be "rolled" into the minor totals.
T F e. When a control break is detected, counters or totals are rolled before they are zeroed.
T F f. Multiple level control break processing requires two hold fields for each level.
T F g. A simple technique for forcing a page break in control break processing is to set the page counter to the maximum allowed.
T F h. Adding control break logic to a program will necessitate a change to the mainline.
T F i. Adding control break logic to a program will necessitate a change to the WRAPUP routine.
T F j. Adding control break logic to a program will necessitate a change to the report DCB.
T F k. Changes in the control break fields are checked prior to formatting the report detail line for the current record.
T F l. Control break logic can be used in summary reports as well as in detail reports.
T F m. A separate line counter is needed for each level of control break processing.

2. (Refer to the Small Town Hardware Store database in More Datasets.) Produce a list of the tools found in each kit. Allow 10 lines per page. Your output should appear as follows:

```
         1         2         3         4
1234567890123456789012345678901234567890
     SMALL TOWN HARDWARE        Page BZZ9

      Kit ID    Tool ID
      ------    -------
       XXX        XXX
                  XXX

       XXX        XXX
                  XXX
                  XXX
```

Exercises

The kit ID should be printed on the first line for that kit, and on the first line for a page if that kit's listing should span a page break. Double space between kits.

3. (Refer to the Small Town Blood Bank database in More Datasets.) Use the donation file to produce a group history summary as follows:

```
         1         2         3
123456789012345678901234567890
    SMALL TOWN BLOOD BANK

                Number of
    Group ID    Donations
    --------    ---------
      XXX         BZZ9
      XXX         BZZ9
      XXX         BZZ9
    --------    ---------
     Total        BZZ9
```

In order to produce this report, the file will need to be sorted by group ID. DOS' SORT command is crude but will suffice. Type the following at the DOS prompt:

```
sort  /+4  <  donation.dat  >  donation.srt
```

This will create a new file, DONATION.SRT, which is sorted beginning with the fourth column of each record. Specify DONATION.SRT as the DDNAME for the input DCB.

4. (Refer to the Small Town Blood Bank database in More Datasets.) Produce a donor history summary as follows:

```
         1         2         3         4         5
12345678901234567890123456789012345678901234567890
              SMALL TOWN BLOOD BANK      Page BZZ9

                  First      Last     Number of
     Donor ID   Donation   Donation   Donations
     --------   --------   --------   ---------
       XXX      mm/dd/yy   mm/dd/yy     BZZ9
       XXX      mm/dd/yy   mm/dd/yy     BZZ9
       XXX      mm/dd/yy   mm/dd/yy     BZZ9
     --------   --------   --------   ---------
      Total                             BZZ9
```

In order to produce this report, the file will need to be sorted by donor ID. DOS' SORT command is crude but will suffice. Type the following at the DOS prompt:

```
sort  /+1  <  donation.dat  >  donation.srt
```

This will create a new file, DONATION.SRT, which is sorted beginning with the first column of each record. Specify DONATION.SRT as the DDNAME for the input DCB.

Exercises

(Hint: reformat the dates from `mmddyy` to `yymmdd`. The minimum date for a particular donor will be the first donation date, and the maximum date will be the last donation date.)

5. (Refer to the Small Town Payroll database in More Datasets.) Use the `HISTORY` file to produce a payroll register for all pay periods. The report should appear as follows, with *one pay period per page*:

```
         1         2         3         4         5
12345678901234567890123456789012345678901234567890
            SMALL TOWN PAYROLL
     Payroll Register for PPED mm/dd/yy

     Employee    Hours        Gross
     --------   -------    -----------
       XXX      BZZ9.99    BZZ,ZZ9.99
       XXX      BZZ9.99    BZZ,ZZ9.99
       XXX      BZZ9.99    BZZ,ZZ9.99
     --------   -------    -----------
      TOTAL     BZZ9.99    BZZ,ZZ9.99

There were BZZ9 checks printed for PPED mm/dd/yy.
```