3. [20 points] Typescript and screenshots

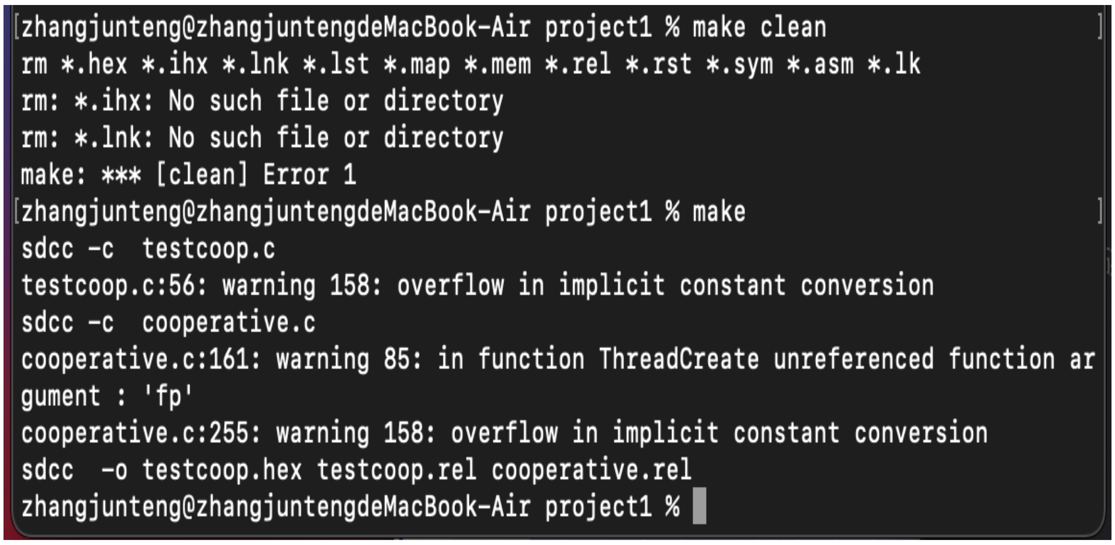
3.1 [2 points] Typescript for compilation

Turn in a typescript showing compilation of your code using the provided Makefile. You should use the following two commands (Note: $ is the prompt displayed by the shell and is not part of the command that you type.) The first one deletes all the compiled files so it forces a rebuild if you have compiled before. The second one compiles it.

$ make clean
$ make

It should show actual compilation, warning, or error messages. Note that not all warnings are errors. The compiler should generate several testcoop.* files with different extensions:

- the .hex file can be opened directly in EdSim51
- the .map file shows the mapping of the symbols to their addresses after linking

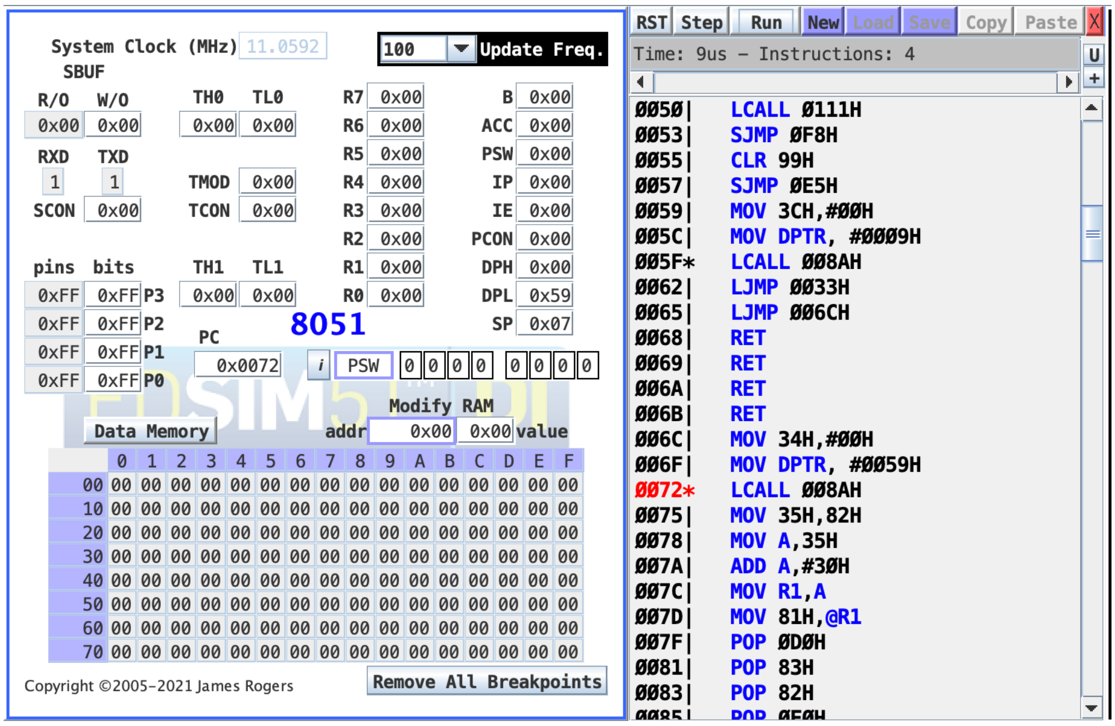


```
zhangjunteng@zhangjuntengdeMacBook-Air project1 % make clean
rm *.hex *.ihx *.lnk *.lst *.map *.mem *.rel *.rst *.sym *.asm *.lk
rm: *.ihx: No such file or directory
rm: *.lnk: No such file or directory
make: *** [clean] Error 1
zhangjunteng@zhangjuntengdeMacBook-Air project1 % make
sdcc -c  testcoop.c
testcoop.c:56: warning 158: overflow in implicit constant conversion
sdcc -c  cooperative.c
cooperative.c:161: warning 85: in function ThreadCreate unreferenced function ar
gument : 'fp'
cooperative.c:255: warning 158: overflow in implicit constant conversion
sdcc  -o testcoop.hex testcoop.rel cooperative.rel
zhangjunteng@zhangjuntengdeMacBook-Air project1 %
```

3.2 [18 points] Screenshots and explanation

Look up the addresses for your symbols (i.e., functions, variables, etc) in the file testcoop.map. Set one or more breakpoints in EdSim51's assembly code window after you have assembled it.

- Take one screenshot before each ThreadCreate call. Explain how the stack changes.



```
System Clock (MHz) 11.0592        100   Update Freq.
SBUF
R/O   W/O      TH0   TL0     R7 0x00      B    0x00
0x00  0x00     0x00  0x00    R6 0x00      ACC  0x00
RXD   TXD                    R5 0x00      PSW  0x00
1     1        TMOD  0x00    R4 0x00      IP   0x00
SCON  0x00     TCON  0x00    R3 0x00      IE   0x00
                             R2 0x00      PCON 0x00
pins  bits     TH1   TL1     R1 0x00      DPH  0x00
0xFF  0xFF P3  0x00  0x00    R0 0x00      DPL  0x59
0xFF  0xFF P2           8051              SP   0x07
0xFF  0xFF P1  PC 0x0072   i  PSW  0 0 0 0  0 0 0 0
0xFF  0xFF P0
                        Modify RAM
Data Memory        addr 0x00   0x00 value
```

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
40	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
50	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

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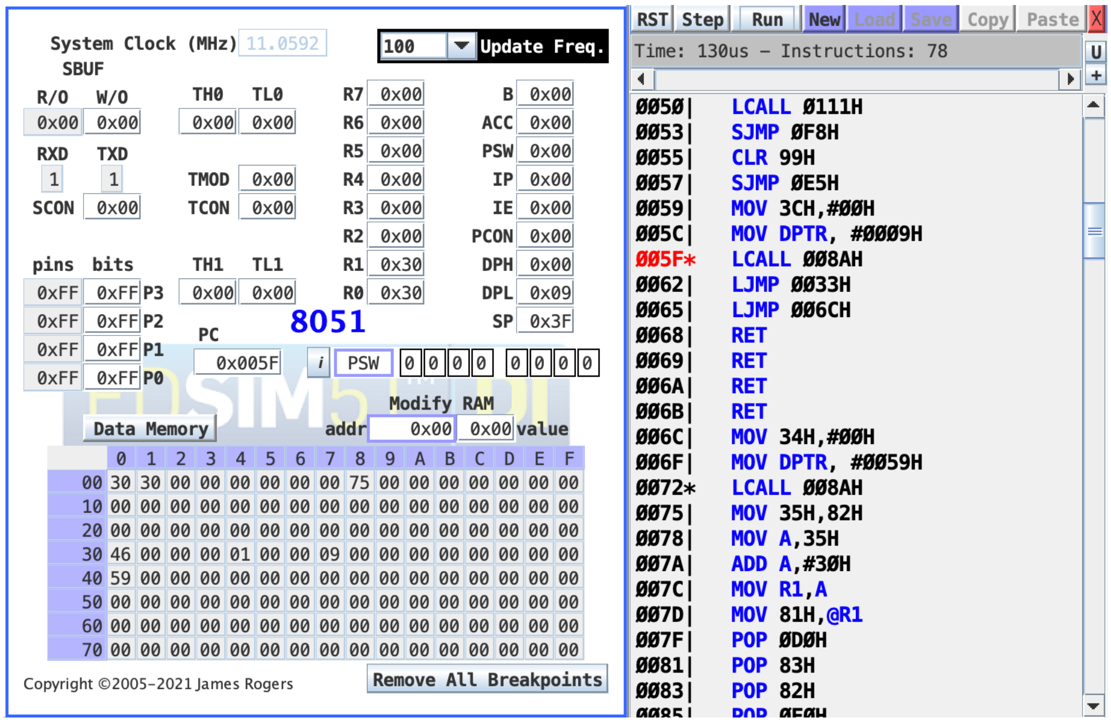
RST Step Run New Load Save Copy Paste X

Time: 9us - Instructions: 4

```
0050|  LCALL 0111H
0053|  SJMP 0F8H
0055|  CLR 99H
0057|  SJMP 0E5H
0059|  MOV 3CH,#00H
005C|  MOV DPTR, #0009H
005F*  LCALL 008AH
0062|  LJMP 0033H
0065|  LJMP 006CH
0068|  RET
0069|  RET
006A|  RET
006B|  RET
006C|  MOV 34H,#00H
006F|  MOV DPTR, #0059H
0072*  LCALL 008AH
0075|  MOV 35H,82H
0078|  MOV A,35H
007A|  ADD A,#30H
007C|  MOV R1,A
007D|  MOV 81H,@R1
007F|  POP 0D0H
0081|  POP 83H
0083|  POP 82H
0085|  POP 0E0H
```

-



```
System Clock (MHz) 11.0592        100  Update Freq.
 SBUF
R/O   W/O       TH0   TL0      R7  0x00        B  0x00
0x00  0x00      0x00  0x00     R6  0x00      ACC  0x00
RXD   TXD                      R5  0x00      PSW  0x00
 1     1        TMOD  0x00     R4  0x00       IP  0x00
SCON  0x00      TCON  0x00     R3  0x00       IE  0x00
                               R2  0x00     PCON  0x00
pins  bits      TH1   TL1      R1  0x30      DPH  0x00
0xFF  0xFF P3   0x00  0x00     R0  0x30      DPL  0x09
0xFF  0xFF P2          8051                   SP  0x3F
0xFF  0xFF P1   PC
0xFF  0xFF P0   0x005F    i  PSW  0 0 0 0  0 0 0 0
                                Modify RAM
Data Memory               addr  0x00  0x00 value
```

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	30	30	00	00	00	00	00	00	75	00	00	00	00	00	00	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	46	00	00	00	01	00	00	09	00	00	00	00	00	00	00	00
40	59	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
50	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

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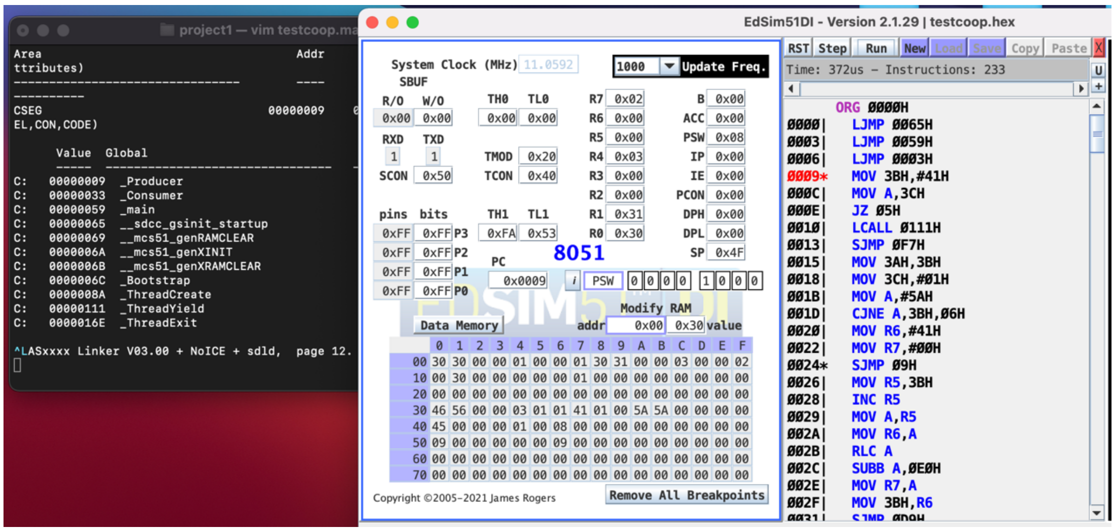
```
Time: 130us - Instructions: 78
ØØ5Ø|   LCALL Ø111H
ØØ53|   SJMP ØF8H
ØØ55|   CLR 99H
ØØ57|   SJMP ØE5H
ØØ59|   MOV 3CH,#ØØH
ØØ5C|   MOV DPTR, #ØØØ9H
ØØ5F*   LCALL ØØ8AH
ØØ62|   LJMP ØØ33H
ØØ65|   LJMP ØØ6CH
ØØ68|   RET
ØØ69|   RET
ØØ6A|   RET
ØØ6B|   RET
ØØ6C|   MOV 34H,#ØØH
ØØ6F|   MOV DPTR, #ØØ59H
ØØ72*   LCALL ØØ8AH
ØØ75|   MOV 35H,82H
ØØ78|   MOV A,35H
ØØ7A|   ADD A,#3ØH
ØØ7C|   MOV R1,A
ØØ7D|   MOV 81H,@R1
ØØ7F|   POP ØDØH
ØØ81|   POP 83H
ØØ83|   POP 82H
```

- Stack was set up by ThreadCreate(main), RESTORESTATE sets SP to the savedSP for stack-0, restore its PSW (which selects register bank 0), DPTR, B, ACC using stack value. Stack 0 now has the return address of main.
-
- Take one screenshot when the Producer is running. How do you know?



project1 — vim testcoop.ma

```
Area                                   Addr
ttributes)
--------------------------------       ----
----------
CSEG                               00000009
EL,CON,CODE)

      Value   Global
      -----   --------------------------------
C:   00000009  _Producer
C:   00000033  _Consumer
C:   00000059  _main
C:   00000065  __sdcc_gsinit_startup
C:   00000069  __mcs51_genRAMCLEAR
C:   0000006A  __mcs51_genXINIT
C:   0000006B  __mcs51_genXRAMCLEAR
C:   0000006C  _Bootstrap
C:   0000008A  _ThreadCreate
C:   00000111  _ThreadYield
C:   0000016E  _ThreadExit

^LASxxxx Linker V03.00 + NoICE + sdld,  page 12.
```

EdSim51DI - Version 2.1.29 | testcoop.hex

```
System Clock (MHz) 11.0592        1000  Update Freq.
 SBUF
R/O   W/O       TH0   TL0      R7  0x02        B  0x00
0x00  0x00      0x00  0x00     R6  0x00      ACC  0x00
RXD   TXD                      R5  0x00      PSW  0x08
 1     1        TMOD  0x20     R4  0x03       IP  0x00
SCON  0x50      TCON  0x40     R3  0x00       IE  0x00
                               R2  0x00     PCON  0x00
pins  bits      TH1   TL1      R1  0x31      DPH  0x00
0xFF  0xFF P3   0xFA  0x53     R0  0x30      DPL  0x00
0xFF  0xFF P2          8051                   SP  0x4F
0xFF  0xFF P1   PC
0xFF  0xFF P0   0x0009    i  PSW  0 0 0 0  1 0 0 0
                                Modify RAM
Data Memory               addr  0x00  0x30 value
```

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	30	30	00	00	01	00	00	01	30	31	00	00	03	00	00	02
10	00	30	00	00	00	00	00	01	00	00	00	00	00	00	00	00
20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	46	56	00	00	03	01	01	41	01	00	5A	5A	00	00	00	00
40	45	00	00	00	01	00	08	00	00	00	00	00	00	00	00	00
50	09	00	00	00	00	00	09	00	00	00	00	00	00	00	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

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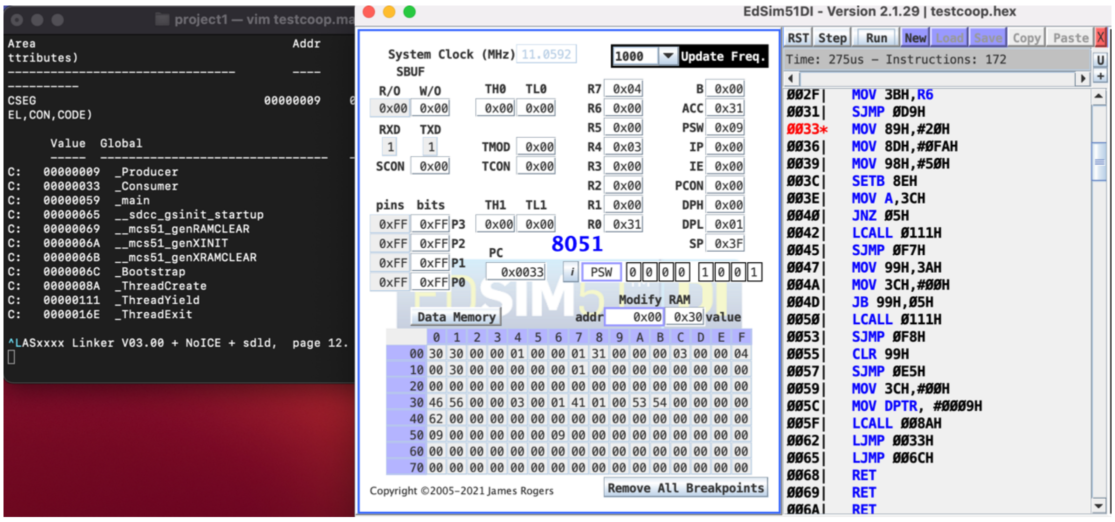
```
Time: 372us - Instructions: 233
        ORG ØØØØH
ØØØØ|   LJMP ØØ65H
ØØØ3|   LJMP ØØ59H
ØØØ6|   LJMP ØØØ3H
ØØØ9*   MOV 3BH,#41H
ØØØC|   MOV A,3CH
ØØØE|   JZ Ø5H
ØØ1Ø|   LCALL Ø111H
ØØ13|   SJMP ØF7H
ØØ15|   MOV 3AH,3BH
ØØ18|   MOV 3CH,#Ø1H
ØØ1B|   MOV A,#5AH
ØØ1D|   CJNE A,3BH,Ø6H
ØØ2Ø|   MOV R6,#41H
ØØ22|   MOV R7,#ØØH
ØØ24*   SJMP Ø9H
ØØ26|   MOV R5,3BH
ØØ28|   INC R5
ØØ29|   MOV A,R5
ØØ2A|   MOV R6,A
ØØ2B|   RLC A
ØØ2C|   SUBB A,ØEØH
ØØ2E|   MOV R7,A
ØØ2F|   MOV 3BH,R6
```

- Stack was set up by ThreadCreate(Producer), and PC point to ThreadCreate. Because we want to run producer. That means the address of producer is passed as a parameter, and that is in DPL and DPH as the address that you want the new thread to run.
-
- Take one screenshot when the Consumer is running. How do you know?



```
Area                                        Addr
ttributes)
--------------------------------          ----
----------
CSEG                                    00000009    0
EL,CON,CODE)

      Value   Global
      -----   --------------------------------
C:    00000009  _Producer
C:    00000033  _Consumer
C:    00000059  _main
C:    00000065  __sdcc_gsinit_startup
C:    00000069  __mcs51_genRAMCLEAR
C:    0000006A  __mcs51_genXINIT
C:    0000006B  __mcs51_genXRAMCLEAR
C:    0000006C  _Bootstrap
C:    0000008A  _ThreadCreate
C:    00000111  _ThreadYield
C:    0000016E  _ThreadExit

^LASxxxx Linker V03.00 + NoICE + sdld,  page 12.
```

EdSim51DI - Version 2.1.29 | testcoop.hex

```
System Clock (MHz) 11.0592        1000  Update Freq.
 SBUF
R/O   W/O      TH0   TL0      R7 0x04     B    0x00
0x00  0x00     0x00  0x00     R6 0x00     ACC  0x31
RXD   TXD                     R5 0x00     PSW  0x09
 1     1       TMOD  0x00     R4 0x03     IP   0x00
SCON  0x00     TCON  0x00     R3 0x00     IE   0x00
                              R2 0x00     PCON 0x00
pins  bits     TH1   TL1      R1 0x00     DPH  0x00
0xFF  0xFF P3  0x00  0x00     R0 0x31     DPL  0x01
0xFF  0xFF P2        8051                 SP   0x3F
0xFF  0xFF P1  PC
0xFF  0xFF P0  0x0033     i  PSW  0 0 0 0  1 0 0 1
                                Modify RAM
Data Memory                addr 0x00  0x30 value
```

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	30	30	00	00	01	00	00	01	31	00	00	00	03	00	00	04
10	00	30	00	00	00	00	00	01	00	00	00	00	00	00	00	00
20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	46	56	00	00	03	00	01	41	01	00	53	54	00	00	00	00
40	62	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
50	09	00	00	00	00	00	09	00	00	00	00	00	00	00	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

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```
Time: 275us - Instructions: 172
002F|   MOV 3BH,R6
0031|   SJMP 0D9H
0033*   MOV 89H,#20H
0036|   MOV 8DH,#0FAH
0039|   MOV 98H,#50H
003C|   SETB 8EH
003E|   MOV A,3CH
0040|   JNZ 05H
0042|   LCALL 0111H
0045|   SJMP 0F7H
0047|   MOV 99H,3AH
004A|   MOV 3CH,#00H
004D|   JB 99H,05H
0050|   LCALL 0111H
0053|   SJMP 0F8H
0055|   CLR 99H
0057|   SJMP 0E5H
0059|   MOV 3CH,#00H
005C|   MOV DPTR, #0009H
005F|   LCALL 008AH
0062|   LJMP 0033H
0065|   LJMP 006CH
0068|   RET
0069|   RET
006A|   RET
```

I set a breakpoint for Consumer() .By observing the stack address, we knew that while calling the Consumer(). The stack space for stack1 which is pointed to 5_H was changed and we knew that Consumer is running.