



AMRITA
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XS Experimental OS

- Case Study

Course Name: Operating Systems

Course Code: 23CSE214

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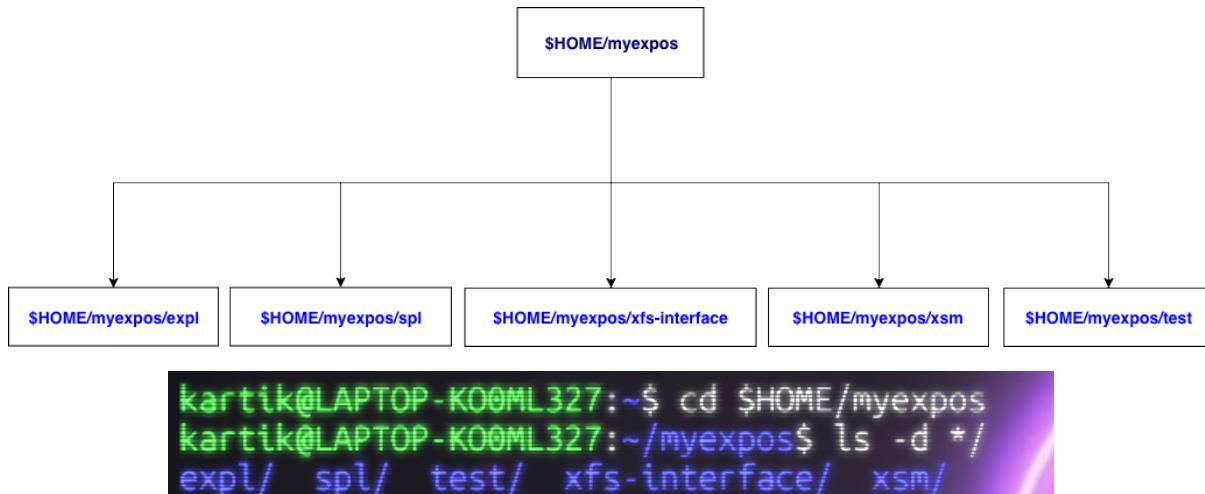
Roll no: CB.SC.U4CSE24744

Class: CSE - H



Stage 1 : Setting up the System

1. sudo apt-get install libreadline-dev flex bison make gcc wget curl
2. curl -sSf https://raw.githubusercontent.com/eXpoSNitc/expos-bootstrap/main/download.sh | sh
3. cd \$HOME/myexpos
4. make



Stage 2 : Understanding the Filesystem

1. Running the XFS Interface
2. XFS-Prompt

```
kartik@LAPTOP-KO0ML327:~/myexpos$ cd $HOME/myexpos/xfs-interface
./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# fdisk
Formatting Complete. "disk.xfs" created.
# exit
```

3. file named **disk.xfs** is created in the location **\$HOME/myexpos/xfs-interface/**

```
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ ls
AUTHORS README.md disk.h diskUtility.h fileSystem.h inodeusertable.txt labels.c virtualDisk.c
LICENSE constants.h disk.xfs exception.c inode.c interface.c labels.h virtualDisk.h
Makefile disk.c diskUtility.c exception.h inode.h interface.h memOrg.h xfs-interface
```

4. df

63	-	130	-	197	-	328	
64	-	131	-	198	-	329	
65	-	132	-	199	-	330	
66	-	133	-	200	-	331	
67	-	134	-	201	-	332	
68	-	135	-	202	-	333	
69	-	136	-	203	-	334	
70	-	137	-	204	-	335	
71	-	138	-	205	-	336	
72	-	139	-	206	-	337	
73	-	140	-	207	-	338	
74	-	141	-	208	-	339	
75	-	142	-	209	-	340	
76	-	143	-	210	-	341	
77	-	144	-	211	-	342	
78	-	145	-	212	-	343	
79	-	146	-	213	-	344	
80	-	147	-	214	-	345	
81	-	148	-	215	-	346	
82	-	149	-	216	-	347	
83	-	150	-	217	-	348	
84	-	151	-	218	-	349	
85	-	152	-	219	-	350	
86	-	153	-	220	-	351	
87	-	154	-	221	-	352	
88	-	155	-	222	-	353	
89	-	156	-	223	-	354	
90	-	157	-	224	-	355	
91	-	158	-	225	-	356	
92	-	159	-	226	-	357	
93	-	160	-	227	-	358	
94	-	161	-	228	-	359	
95	-	162	-	229	-	360	
96	-	163	-	230	-	361	
97	-	164	-	231	-	362	
98	-	165	-	232	-	363	
99	-	166	-	233	-	364	
100	-	167	-	234	-	365	
101	-	168	-	235	-	366	
102	-	169	-	236	-	367	
103	-	170	-	237	-	368	
104	-	171	-	238	-	369	
105	-	172	-	239	-	370	
106	-	173	-	240	-	371	
107	-	174	-	241	-	372	
108	-	175	-	242	-	373	
109	-	176	-	243	-	374	
110	-	177	-	244	-	375	
111	-	178	-	245	-	376	
112	-	179	-	246	-	377	
113	-	180	-	247	-	378	
114	-	181	-	248	-	379	
115	-	182	-	249	-	380	
116	-	183	-	250	-	381	No of Free Blocks = 443
117	-	184	-	251	-	382	Total no of Blocks = 512
118	-	185	-	252	-	383	
119	-	186	-	253	-	384	
120	-	187	-	254	-	385	
121	-	188	-	255	-	386	
122	-	189	-	256	-	387	
123	-	190	-	257	-	388	
124	-	191	-	258	-	389	
125	-	192	-	259	-	390	
126	-	193	-	260	-	391	
127	-	194	-	261	-	392	
128	-	195	-	262	-	393	
129	-	196	-	263	-	394	

5. sample.dat

There is a place where the sidewalk ends
And before the street begins,
And there the grass grows soft and white,
And there the sun burns crimson bright,
And there the moon-bird rests from his flight
To cool in the peppermint wind.

6. loading the file to the XFS disk

```
kartik@LAPTOP-KO0ML327:~/myexpos$ nvim sample.dat
kartik@LAPTOP-KO0ML327:~/myexpos$ cd $HOME/myexpos/xfs-interface
./xfs-interface
Unix-XFS Interface Version 2.0.
Type "help" for getting a list of commands.
# load --data $HOME/myexpos/sample.dat
```

7.

```
# copy 3 4 $HOME/myexpos/inode_table.txt  
# df
```

block 69 - this is because the 1st free block that is allocated by the allocator

67	-	1
68	-	1
69	-	1
70	-	0
71	-	0

Inode table.txt:

So on ...

- Using dump to write the contents of the **inodetable** into the file \$HOME/myexpos/xfs-interface/**inodeusertable.txt**

9. Copying the data blocks from the XFS disk and display it as a UNIX file \$HOME/myexpos/data.txt.

```
kartik@LAPTOP-K00ML327:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# copy 69 69 $HOME/myexpos/data.txt
# exit
kartik@LAPTOP-K00ML327:~/myexpos/xfs-interface$ cd ..
kartik@LAPTOP-K00ML327:~/myexpos$ cat data.txt
There is a place where the sidewalk ends
And before the street begins,
And there the grass grows soft and white,
And there the sun burns crimson bright,
And there the moon-bird rests from his flight
To cool in the peppermint wind
.
```

10. Verifying that using the export command results the same as copying the XFS disk content

```
kartik@LAPTOP-K00ML327:~/myexpos$ cd xfs-interface/
kartik@LAPTOP-K00ML327:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interace Version 2.0.
Type "help" for getting a list of commands.
# export sample.dat $HOME/myexpos/data.txt
# exit
kartik@LAPTOP-K00ML327:~/myexpos/xfs-interface$ cd ..
kartik@LAPTOP-K00ML327:~/myexpos$ cat data.txt
There is a place where the sidewalk ends
And before the street begins,
And there the grass grows soft and white,
And there the sun burns crimson bright,
And there the moon-bird rests from his flight
To cool in the peppermint wind
.
```

Assignment – 1:

Copy the contents of Root File (from Block 5 of XFS disk) to a UNIX file \$HOME/myexpos/root_file.txt and verify that an entry for sample.dat is made in it also.

... so on

Assignment – 2:

Delete the sample.dat from the XSM machine using xfs-interface and note the changes for the entries for this file in *inode table, root file and disk free list*.

Deleting sample.dat

```
kartik@LAPTOP-K00ML327:~/myexpos$ cd xfs-interface/
kartik@LAPTOP-K00ML327:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interface Version 2.0.
Type "help" for getting a list of commands.
# rm sample.dat
# exit
```

Getting the root file values to root_file.txt

```
kartik@LAPTOP-KO0ML327:~/myexpos$ cd xfs-interface/
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interface Version 2.0.
Type "help" for getting a list of commands.
# rm sample.dat
# exit
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ ./xfs-interface
Unix-XFS Interface Version 2.0.
Type "help" for getting a list of commands.
# dump --inodeusertable
# copy 5 5 $HOME/myexpos/root_file.txt
# df
```

Inodeusertable.txt (no sample.dat inode user table entry found)

Root_file.txt (no entry for sample.dat found)

```
kartik@LAPTOP-KO0ML327:~/myexpos$ cat root_file.txt
```

```
root
```

```
512
```

```
1
```

```
-1
```

```
-1
```

```
-1
```

```
-1
```

```
-1
```

```
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```
-1
```

69th block freed (disk free list):

0	-	-
1	-	-
2	-	-
3	-	-
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	-	-
11	-	-
12	-	-
13	-	-
14	-	-
15	-	-
16	-	-
17	-	-
18	-	-
19	-	-
20	-	-
21	-	-
22	-	-
23	-	-
24	-	-
25	-	-
26	-	-
27	-	-
28	-	-
29	-	-
30	-	-
31	-	-
32	-	-
33	-	-
34	-	-
35	-	-
36	-	-
37	-	-
38	-	-
39	-	-
40	-	-
41	-	-
42	-	-
43	-	-
44	-	-
45	-	-
46	-	-
47	-	-
48	-	-
49	-	-
50	-	-
51	-	-
52	-	-
53	-	-
54	-	-
55	-	-
56	-	-
57	-	-
58	-	-
59	-	-
60	-	-
61	-	-
62	-	-
63	-	-
64	-	-
65	-	-
66	-	-
67	-	-
68	-	-
69	-	0
70	-	0

Stage 3: Bootstrap Loader

```
kartik@LAPTOP-KO0ML327:~/myexpos$ mkdir stage3
kartik@LAPTOP-KO0ML327:~/myexpos$ cd stage3/
kartik@LAPTOP-KO0ML327:~/myexpos/stage3$ nvim helloworld.xsm
kartik@LAPTOP-KO0ML327:~/myexpos/stage3$ cat helloworld.xsm
MOV R0, "HELLO_WORLD"
MOV R16, R0
PORT P1, R16
OUT
HALT
kartik@LAPTOP-KO0ML327:~/myexpos/stage3$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd xfs-interface/
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ ./xfs-interface load --os ../stage3/helloworld.xsm
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd xsm/
kartik@LAPTOP-KO0ML327:~/myexpos/xsm$ ./xsm
HELLO_WORLD
Machine is halting.
```

Assignment:

```
kartik@LAPTOP-KO0ML327:~/myexpos/stage3/assignment$ nvim printNumbers.xsm
kartik@LAPTOP-KO0ML327:~/myexpos/stage3/assignment$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos/stage3$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd xfs-interface/
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ ./xfs-interface load --os ../stage3/assignment/printNumbers.xsm
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd xsm/
kartik@LAPTOP-KO0ML327:~/myexpos/xsm$ ./xsm
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Machine is halting.
```

Code:

```
kartik@LAPTOP-KO0ML327:~/myexpos/stage3/assignment$ cat printNumbers.xsm
MOV R0, 1
MOV R1, 20
AGAIN:
MOV R16, R0
PORT P1, R16
OUT
INR R0
DCR R1
JNZ R1, AGAIN

HALT
```

Stage 4: Learning the SPL Language

```
kartik@LAPTOP-KO0ML327:~/myexpos$ mkdir stage4
kartik@LAPTOP-KO0ML327:~/myexpos$ cd stage4
kartik@LAPTOP-KO0ML327:~/myexpos/stage4$ nvim oddnos.spl
kartik@LAPTOP-KO0ML327:~/myexpos/stage4$ cat oddnos.spl
alias counter R0;
counter = 0;
while(counter<=20) do
    if(counter%2 != 0) then
        print counter;
    endif;
    counter = counter + 1;
endwhile;
kartik@LAPTOP-KO0ML327:~/myexpos/stage4$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd spl/
kartik@LAPTOP-KO0ML327:~/myexpos/spl$ ./spl $HOME/myexpos/stage4/oddnos.spl
kartik@LAPTOP-KO0ML327:~/myexpos/spl$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd stage4
kartik@LAPTOP-KO0ML327:~/myexpos/stage4$ cat oddnos.xsm
MOV R0, 0
_L1:
MOV R16, 20
GE R16, R0
JZ R16, _L2
MOV R16, R0
MOD R16, 2
MOV R17, 0
NE R16, R17
JZ R16, _L3
MOV R16, R0
PORT P1, R16
OUT
JMP _L4
_L3:
_L4:
MOV R16, R0
ADD R16, 1
MOV R0, R16
JMP _L1
_L2:
HALT
kartik@LAPTOP-KO0ML327:~/myexpos/stage4$
```

```
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ ./xfs-interface load --os ../stage4/oddnos.xsm
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd xsm/
kartik@LAPTOP-KO0ML327:~/myexpos/xsm$ ./xsm
1
3
5
7
9
11
13
15
17
19
Machine is halting.
kartik@LAPTOP-KO0ML327:~/myexpos/xsm$ |
```



Assignment:

```
kartik@LAPTOP-KO0ML327:~/myexpos/stage4/assignment$ nvim sumofsquares.spl
kartik@LAPTOP-KO0ML327:~/myexpos/stage4/assignment$ cat sumofsquares.spl
alias counter R0;
alias sum R1;
counter = 1;
sum = 0;
while(counter<=20) do
    sum = sum + (counter*counter);
    counter = counter + 1;
endwhile;
print sum;

kartik@LAPTOP-KO0ML327:~/myexpos/stage4/assignment$ cd ../../
kartik@LAPTOP-KO0ML327:~/myexpos$ cd spl
kartik@LAPTOP-KO0ML327:~/myexpos/spl$ ./spl $HOME//myexpos/stage4/assignment/sumofsquares.spl
kartik@LAPTOP-KO0ML327:~/myexpos/spl$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd xfs-interface/
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ ./xfs-interface load --os $HOME/myexpos/stage4/assignment/sumofsquares.xsm
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos$ cd xsm/
kartik@LAPTOP-KO0ML327:~/myexpos/xsm$ ./xsm
2870
Machine is halting.
```



Stage 5: XSM Debugging

```
kartik@LAPTOP-KO0ML327:~/myexpos$ mkdir stage5
kartik@LAPTOP-KO0ML327:~/myexpos$ cd stage5
kartik@LAPTOP-KO0ML327:~/myexpos/stage5$ nvim oddnos.spl
kartik@LAPTOP-KO0ML327:~/myexpos/stage5$ cat oddnos.spl
alias counter R0;
counter = 0;
while(counter <= 10) do
    if(counter%2 != 0) then
        breakpoint;
    endif;
    counter = counter + 1;
endwhile;
```

kartik@LAPTOP-KO0ML327:~/myexpos/spl\$./spl \$HOME/myexpos/stage5/oddnos.spl
kartik@LAPTOP-KO0ML327:~/myexpos/spl\$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos\$ cd xfs-interface/
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface\$./xfs-interface load --os \$HOME/myexpos/stage5/oddnos.xsm
kartik@LAPTOP-KO0ML327:~/myexpos/xfs-interface\$ cd ..
kartik@LAPTOP-KO0ML327:~/myexpos\$ cd xsm/
kartik@LAPTOP-KO0ML327:~/myexpos/xsm\$./xsm --debug
Previous instruction at IP = 530: BRKP
Mode: KERNEL PID: -1
Next instruction at IP = 532, Page No. = 1: JMP 534
debug> reg
R0: 1 R1: R2: R3: R4:
R5: R6: R7: R8: R9:
R10: R11: R12: R13: R14:
R15: R16: 1 R17: 0 R18: R19:
P0: P1: P2: P3:
BP: SP: IP: 532 PTBR: PTLR:
EIP: EC: EPN: EMA:
debug> mem 1
Page: 1
Written to file mem
debug> s
Previous instruction at IP = 532: JMP 534
Mode: KERNEL PID: -1
Next instruction at IP = 534, Page No. = 1: MOV R16,R0
debug> reg
R0: 1 R1: R2: R3: R4:
R5: R6: R7: R8: R9:
R10: R11: R12: R13: R14:
R15: R16: 1 R17: 0 R18: R19:
P0: P1: P2: P3:
BP: SP: IP: 534 PTBR: PTLR:
EIP: EC: EPN: EMA:
debug> c
Previous instruction at IP = 530: BRKP
Mode: KERNEL PID: -1
Next instruction at IP = 532, Page No. = 1: JMP 534
debug> reg
R0: 3 R1: R2: R3: R4:
R5: R6: R7: R8: R9:
R10: R11: R12: R13: R14:
R15: R16: 1 R17: 0 R18: R19:
P0: P1: P2: P3:
BP: SP: IP: 532 PTBR: PTLR:
EIP: EC: EPN: EMA:

debug> c
Previous instruction at IP = 530: BRKP
Mode: KERNEL PID: -1
Next instruction at IP = 532, Page No. = 1: JMP 534
debug> reg
R0: 5 R1: R2: R3: R4:
R5: R6: R7: R8: R9:
R10: R11: R12: R13: R14:
R15: R16: 1 R17: 0 R18: R19:
P0: P1: P2: P3:
BP: SP: IP: 532 PTBR: PTLR:
EIP: EC: EPN: EMA:
debug> c
Previous instruction at IP = 530: BRKP
Mode: KERNEL PID: -1
Next instruction at IP = 532, Page No. = 1: JMP 534
debug> c
Previous instruction at IP = 530: BRKP
Mode: KERNEL PID: -1
Next instruction at IP = 532, Page No. = 1: JMP 534
debug> c
Machine is halting.

```
kartik@LAPTOP-KO0ML327:~/myexpos/xsm$ cat mem
Page: 1
0: MOV R0,
1: 0
2: MOV R16,
3: 10
4: GE R16,
5: R0
6: JZ R16,
7: 542
8: MOV R16,
9: R0
10: MOD R16,
11: 2
12: MOV R17,
13: 0
14: NE R16,
15: R17
16: JZ R16,
17: 534
18: BRKP
19:
20: JMP 534
21:
22: MOV R16,
23: R0
24: ADD R16,
25: 1
26: MOV R0,
27: R16
28: JMP 514
29:
30: HALT
```