CS 6345 – Digital Forensics
Assignment-1
Stage-2

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Your job is to investigate the content of a given malicious pdf file. Using the PDF analyzing tools offered by the REMnux tool, spider monkey, sctest, or PDF Stream Dumper, address the following questions/activities:

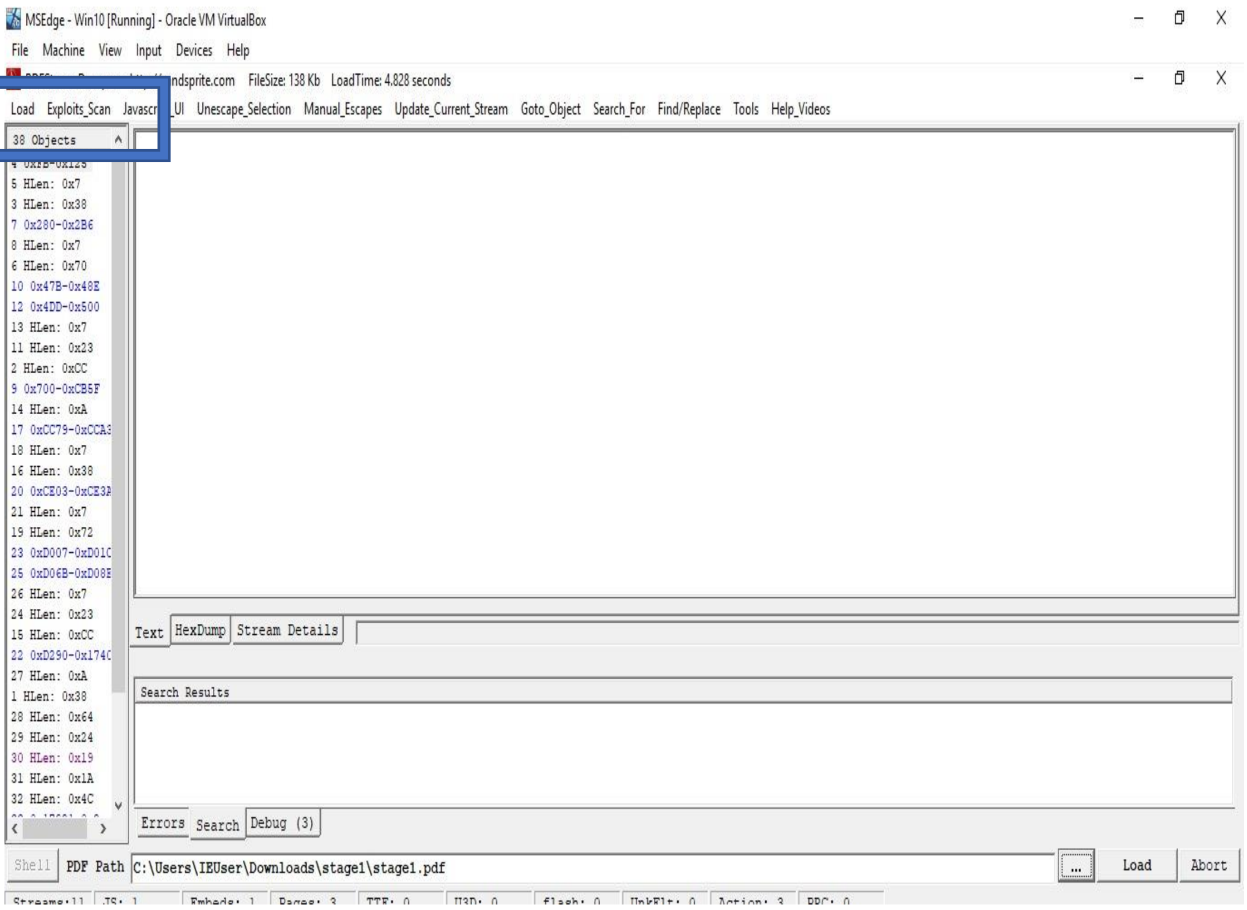
1. Report the number of objects in the file.
2. Determine whether the file is compressed or not.
3. Determine whether the file is obfuscated or not.
4. Find and Extract JavaScript.
5. De-obfuscate JavaScript.
6. Extract the shell code.
7. Create a shell code executable
8. Analyze shell code and determine what is does or even execute it using sctest or spider monkey.
9. What is the secret code?

Answers:

The stage 2 of the assignment is executed using pdf stream dumper.

1. Report the number of objects in the file.

Answer: The number of objects in the file are **38**


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
ndsprite.com FileSize: 138 Kb LoadTime: 4.828 seconds
Load Exploits_Scan Javascr _UI Unescape_Selection Manual_Escapes Update_Current_Stream Goto_Object Search_For Find/Replace Tools Help_Videos
Text HexDump Stream Details
Search Results
Errors Search Debug (3)
Shell PDF Path
Load Abort

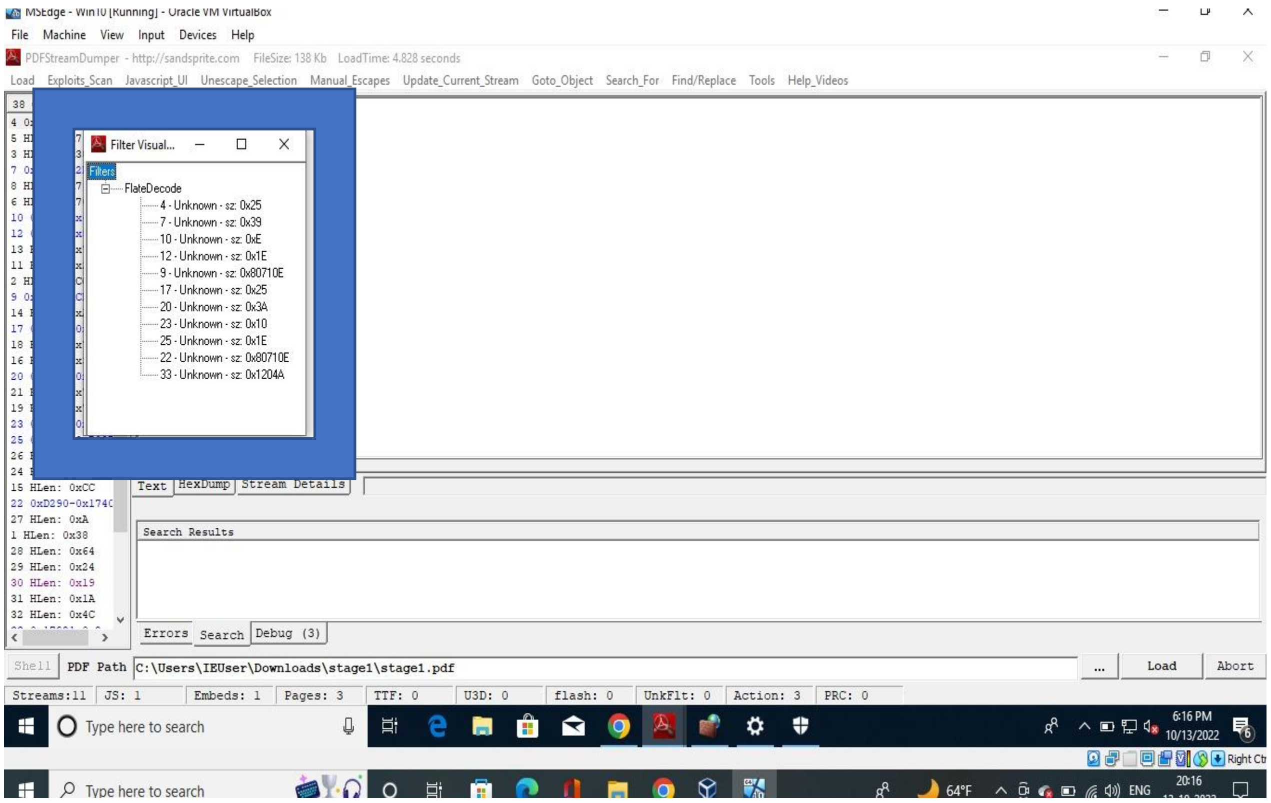
```
38 Objects
5 HLen: 0x7
3 HLen: 0x38
7 0x280-0x2B6
8 HLen: 0x7
6 HLen: 0x70
10 0x47B-0x48E
12 0x4DD-0x500
13 HLen: 0x7
11 HLen: 0x23
2 HLen: 0xCC
9 0x700-0xCB5F
14 HLen: 0xA
17 0xCC79-0xCCA3
18 HLen: 0x7
16 HLen: 0x38
20 0xCE03-0xCE3A
21 HLen: 0x7
19 HLen: 0x72
23 0xD007-0xD01C
25 0xD06B-0xD08E
26 HLen: 0x7
24 HLen: 0x23
15 HLen: 0xCC
22 0xD290-0x174C
27 HLen: 0xA
1 HLen: 0x38
28 HLen: 0x64
29 HLen: 0x24
30 HLen: 0x19
31 HLen: 0x1A
32 HLen: 0x4C
```

```
C:\Users\IEUser\Downloads\stage1\stage1.pdf
```

```
Streams:11  JS: 1  Embeds: 1  Pages: 3  TTF: 0  U3D: 0  flash: 0  UnkFlt: 0  Action: 3  PRC: 0
```

2. Determine whether the file is compressed or not.

Answer: Yes, the file is compressed. As there are filters in the given pdf file (analyzed using pdf stream dumper), we can say that the file is compressed.



MSEdge - Win10 [Running] - Oracle VM VirtualBox

PDFStreamDumper - http://sandsprite.com FileSize: 138 Kb LoadTime: 4.828 seconds

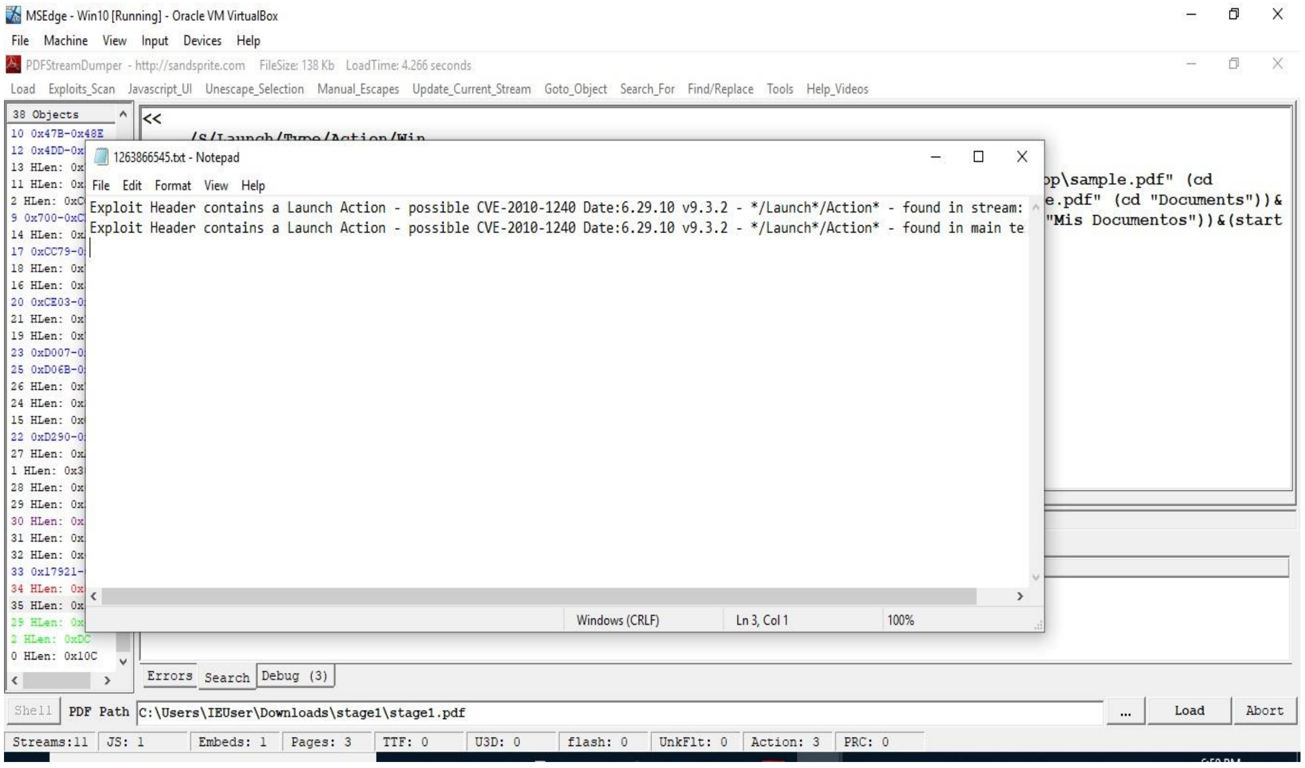
```
Filters
⊟---- FlateDecode
        ---- 4 - Unknown - sz: 0x25
        ---- 7 - Unknown - sz: 0x39
        ---- 10 - Unknown - sz: 0xE
        ---- 12 - Unknown - sz: 0x1E
        ---- 9 - Unknown - sz: 0x80710E
        ---- 17 - Unknown - sz: 0x25
        ---- 20 - Unknown - sz: 0x3A
        ---- 23 - Unknown - sz: 0x10
        ---- 25 - Unknown - sz: 0x1E
        ---- 22 - Unknown - sz: 0x80710E
        ---- 33 - Unknown - sz: 0x1204A
```

```
15 HLen: 0xCC
22 0xD290-0x174C
27 HLen: 0xA
1 HLen: 0x38
28 HLen: 0x64
29 HLen: 0x24
30 HLen: 0x19
31 HLen: 0x1A
32 HLen: 0x4C
```

PDF Path C:\Users\IEUser\Downloads\stage1\stage1.pdf

```
Streams:11 | JS: 1 | Embeds: 1 | Pages: 3 | TTF: 0 | U3D: 0 | flash: 0 | UnkFlt: 0 | Action: 3 | PRC: 0
```

3. Determine whether the file is obfuscated or not.
Answer: Yes, the file is obfuscated. As the header contains the launch action, we can write that the file is obfuscated.


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PDFStreamDumper - http://sandsprite.com FileSize: 138 Kb LoadTime: 4.266 seconds
Load Exploits_Scan Javascript_UI Unescape_Selection Manual_Escapes Update_Current_Stream Goto_Object Search_For Find/Replace Tools Help_Videos
1263866545.txt - Notepad
File Edit Format View Help
Errors Search Debug (3)
Shell PDF Path
Load Abort
Windows (CRLF) Ln 3, Col 1 100%

```
38 Objects
10 0x47B-0x48E
12 0x4DD-0x
13 HLen: 0x
11 HLen: 0x
2 HLen: 0xC
9 0x700-0xC
14 HLen: 0x
17 0xCC79-0
18 HLen: 0x
16 HLen: 0x
20 0xCE03-0
21 HLen: 0x
19 HLen: 0x
23 0xD007-0
25 0xD06B-0
26 HLen: 0x
24 HLen: 0x
15 HLen: 0x
22 0xD290-0
27 HLen: 0x
1 HLen: 0x3
28 HLen: 0x
29 HLen: 0x
30 HLen: 0x
31 HLen: 0x
32 HLen: 0x
33 0x17921-
34 HLen: 0x
35 HLen: 0x
29 HLen: 0x
2 HLen: 0xDC
0 HLen: 0x10C
```

```
<<
     /S/Launch/Type/Action/Win
p\sample.pdf" (cd
e.pdf" (cd "Documents"))&
"Mis Documentos"))&(start
```

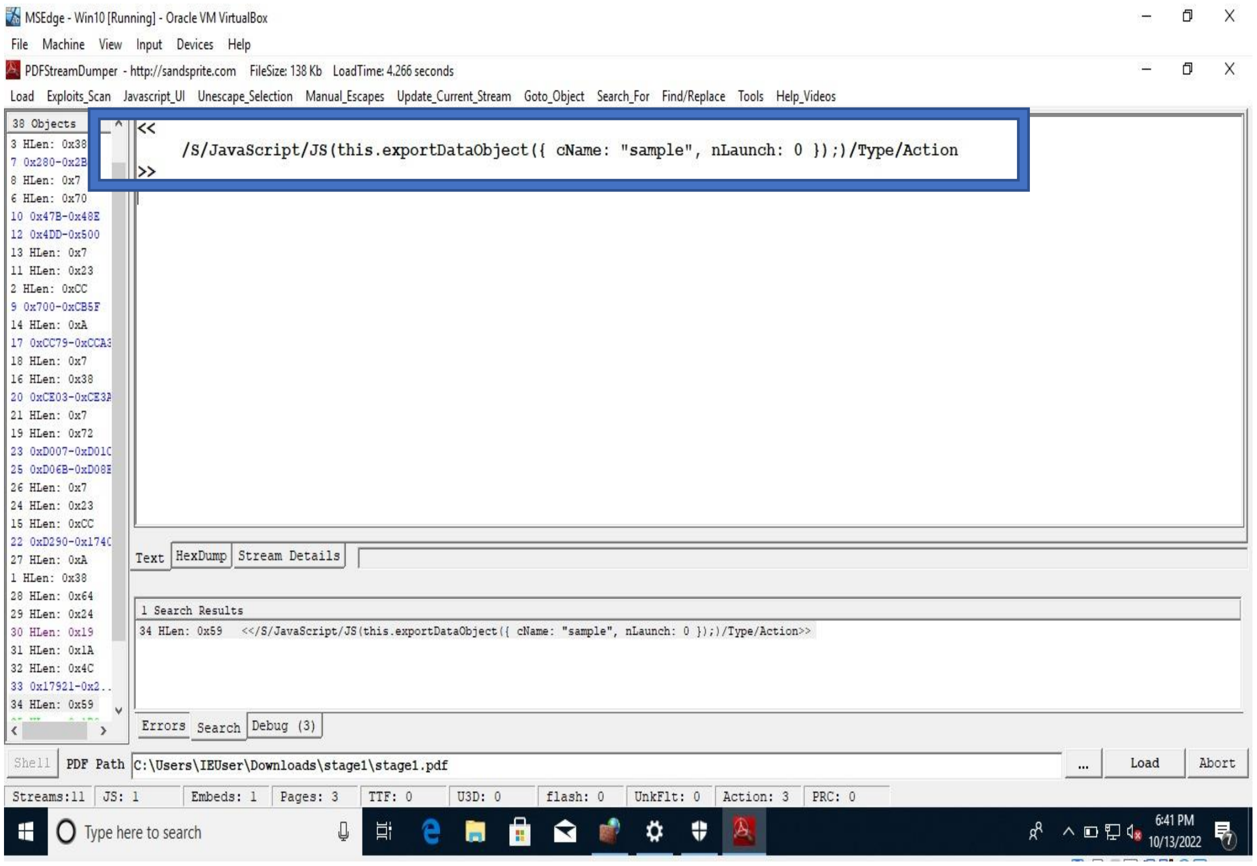
```
Exploit Header contains a Launch Action - possible CVE-2010-1240 Date:6.29.10 v9.3.2 - */Launch*/Action* - found in stream:
Exploit Header contains a Launch Action - possible CVE-2010-1240 Date:6.29.10 v9.3.2 - */Launch*/Action* - found in main te
```

```
C:\Users\IEUser\Downloads\stage1\stage1.pdf
```

```
Streams:11 | JS: 1 | Embeds: 1 | Pages: 3 | TTF: 0 | U3D: 0 | flash: 0 | UnkFlt: 0 | Action: 3 | PRC: 0
```

4. Find and Extract JavaScript.

Answer: The extract JavaScript is shown below.


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PDFStreamDumper - http://sandsprite.com FileSize: 138 Kb LoadTime: 4.266 seconds
Load Exploits_Scan Javascript_UI Unescape_Selection Manual_Escapes Update_Current_Stream Goto_Object Search_For Find/Replace Tools Help_Videos
Text HexDump Stream Details
Errors Search Debug (3)
Shell
Load
Abort
Type here to search
6:41 PM
10/13/2022

```
38 Objects
3 HLen: 0x38
7 0x280-0x2B
8 HLen: 0x7
6 HLen: 0x70
10 0x47B-0x48E
12 0x4DD-0x500
13 HLen: 0x7
11 HLen: 0x23
2 HLen: 0xCC
9 0x700-0xCB5F
14 HLen: 0xA
17 0xCC79-0xCCA3
18 HLen: 0x7
16 HLen: 0x38
20 0xCE03-0xCE3A
21 HLen: 0x7
19 HLen: 0x72
23 0xD007-0xD01C
25 0xD06B-0xD08E
26 HLen: 0x7
24 HLen: 0x23
15 HLen: 0xCC
22 0xD290-0x1740
27 HLen: 0xA
1 HLen: 0x38
28 HLen: 0x64
29 HLen: 0x24
30 HLen: 0x19
31 HLen: 0x1A
32 HLen: 0x4C
33 0x17921-0x2..
34 HLen: 0x59
```

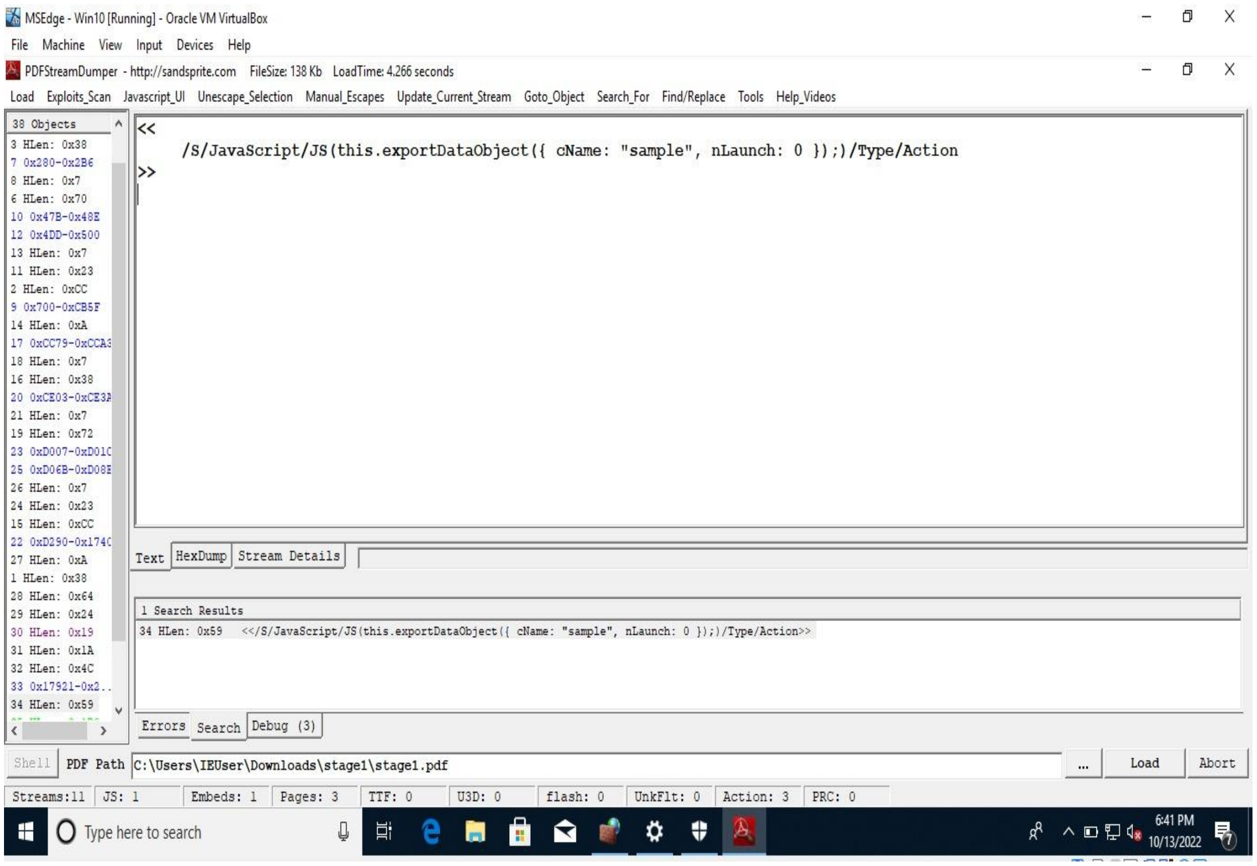
```
<<
     /S/JavaScript/JS(this.exportDataObject({ cName: "sample", nLaunch: 0 });)/Type/Action
>>
```

```
1 Search Results
34 HLen: 0x59    <</S/JavaScript/JS(this.exportDataObject({ cName: "sample", nLaunch: 0 });)/Type/Action>>
```

```
PDF Path C:\Users\IEUser\Downloads\stage1\stage1.pdf
Streams:11 | JS: 1 | Embeds: 1 | Pages: 3 | TTF: 0 | U3D: 0 | flash: 0 | UnkFlt: 0 | Action: 3 | PRC: 0
```

5. De-obfuscate JavaScript.

Answer: The De-obfuscated JavaScript is shown below:



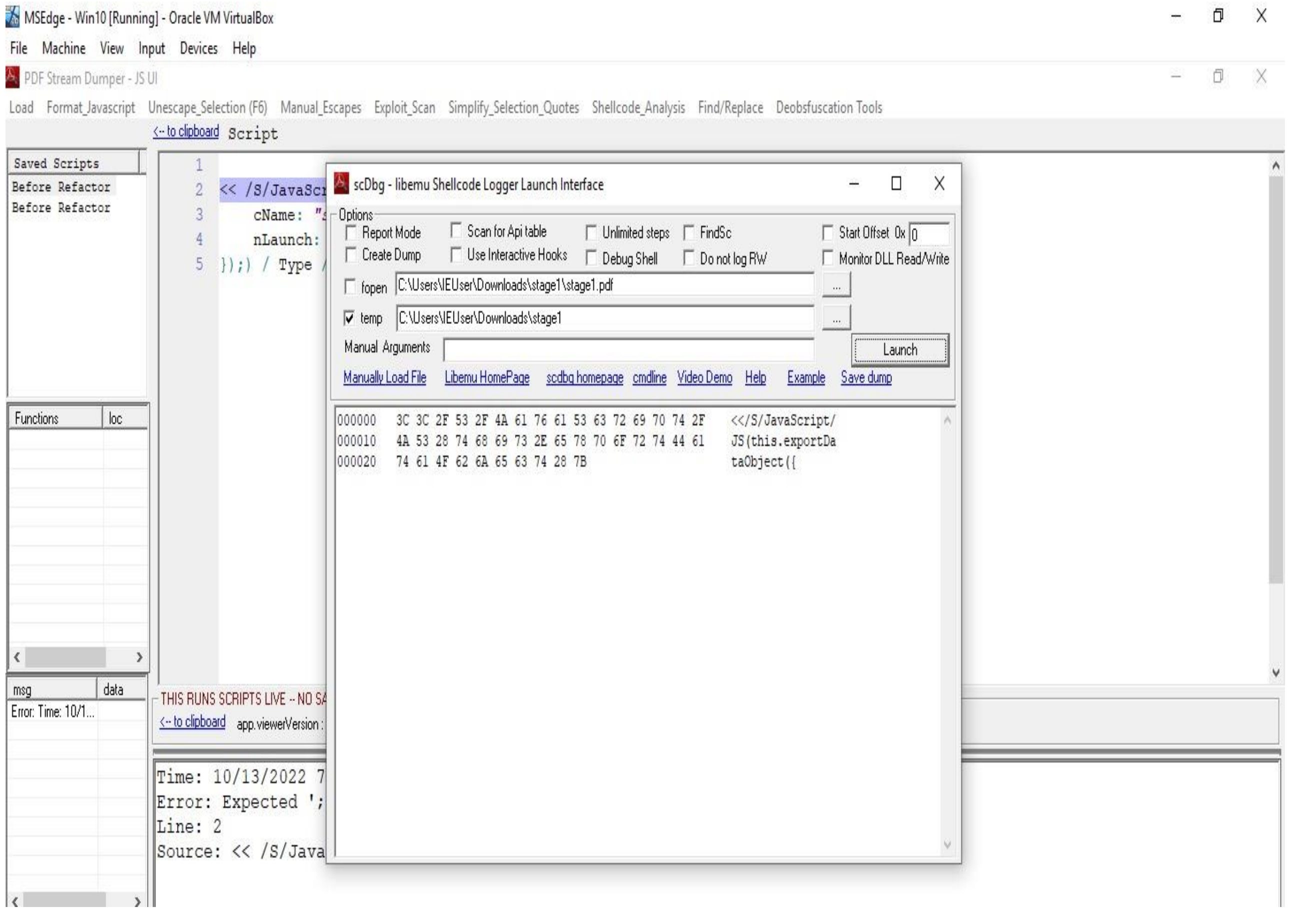
```
<<
    /S/JavaScript/JS(this.exportDataObject({ cName: "sample", nLaunch: 0 });)/Type/Action
>>
```

```
1 Search Results
34 HLen: 0x59   <</S/JavaScript/JS(this.exportDataObject({ cName: "sample", nLaunch: 0 });)/Type/Action>>
```

```
PDF Path C:\Users\IEUser\Downloads\stage1\stage1.pdf
Streams:11  JS: 1  Embeds: 1  Pages: 3  TTF: 0  U3D: 0  flash: 0  UnkFlt: 0  Action: 3  PRC: 0
```

6. Extract the shell code.

Answer: The extracted shell code is:

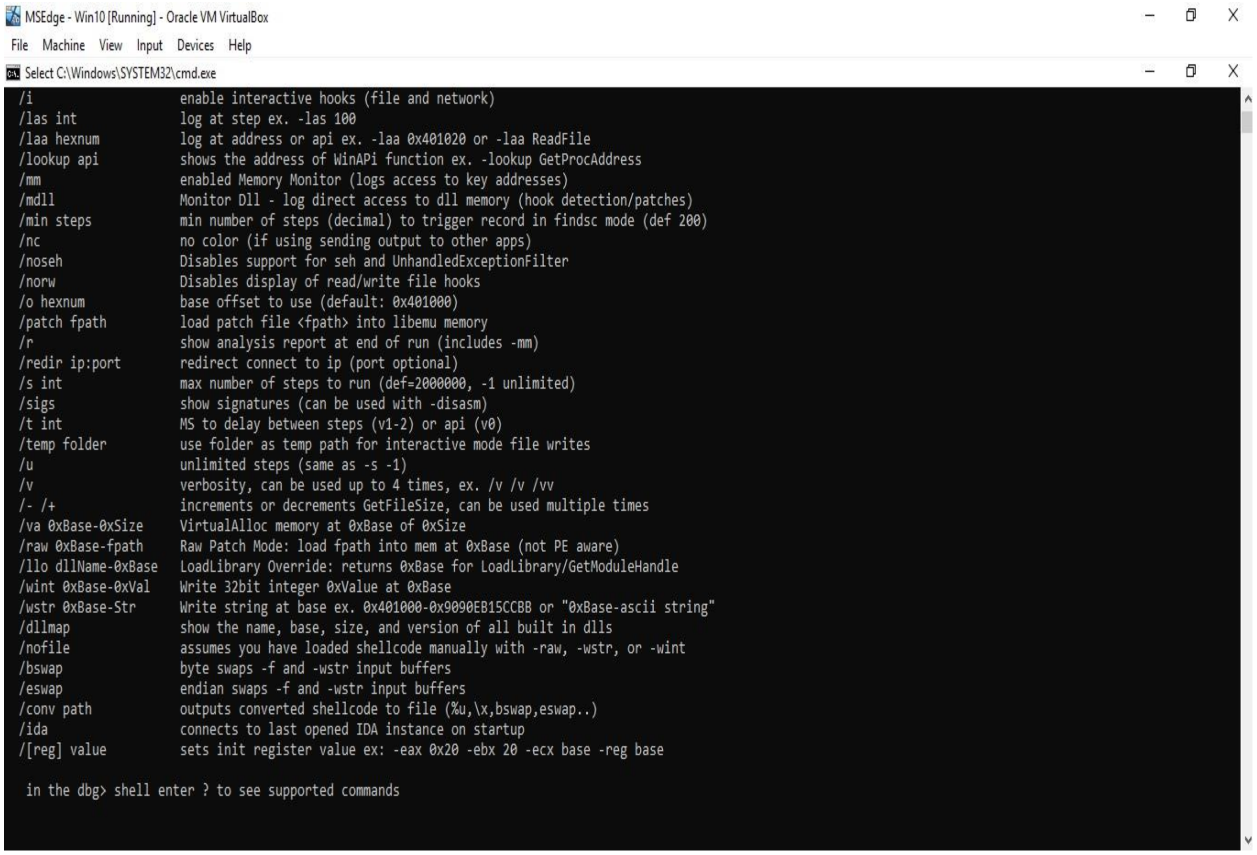

MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PDF Stream Dumper - JS UI
Load Format_Javascript Unescape_Selection (F6) Manual_Escapes Exploit_Scan Simplify_Selection_Quotes Shellcode_Analysis Find/Replace Deobsfuscation Tools
<-- to clipboard Script
Saved Scripts
Before Refactor
Before Refactor
Functions loc
msg data
Error: Time: 10/1...
THIS RUNS SCRIPTS LIVE -- NO SA
<-- to clipboard app.viewerVersion :
scDbg - libemu Shellcode Logger Launch Interface
Options
Launch
Manually Load File Libemu HomePage scdbg homepage cmdline Video Demo Help Example Save dump

```
<< /S/JavaScr
    cName: "s
    nLaunch:
});) / Type /
```

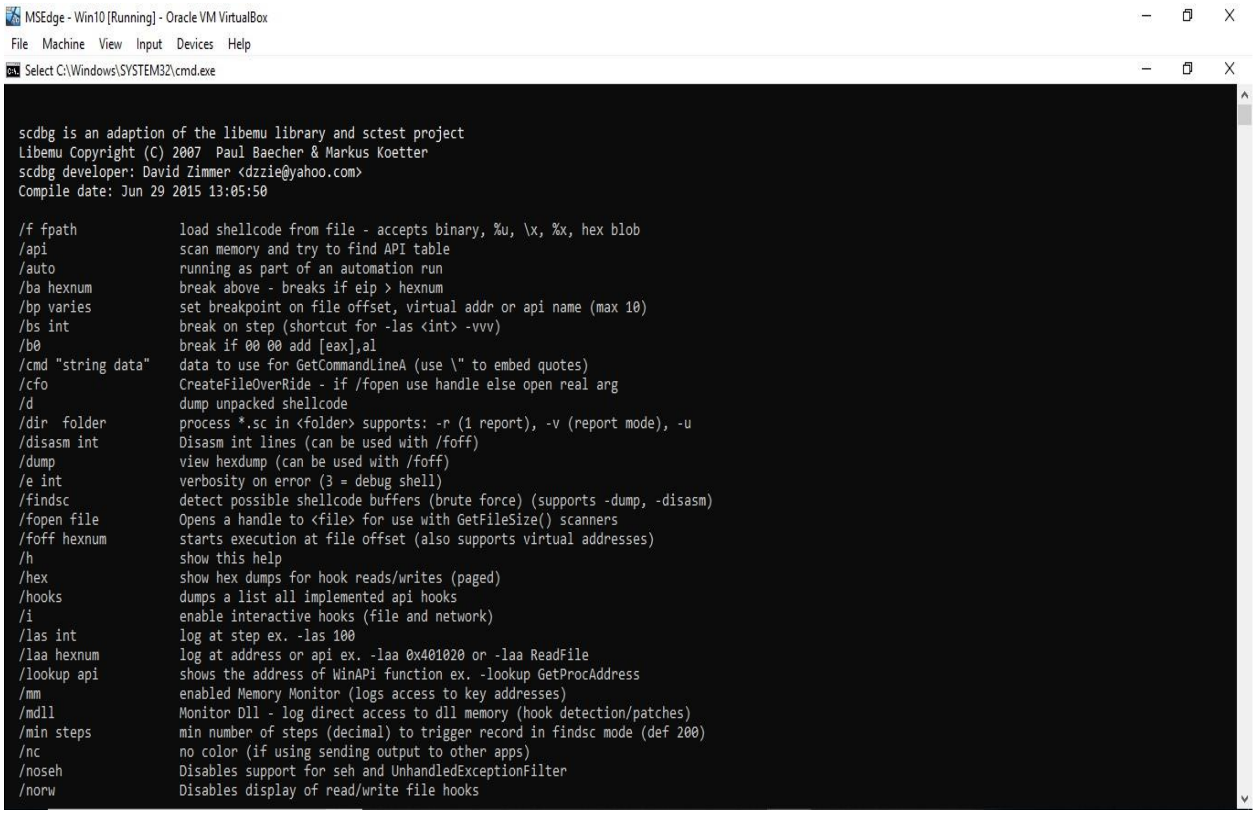
```
Time: 10/13/2022 7
Error: Expected ';
Line: 2
Source: << /S/Java
```

Report Mode [ ] Scan for Api table [ ] Unlimited steps [ ] FindSc [ ] Start Offset 0x 0 [ ]
Create Dump [ ] Use Interactive Hooks [ ] Debug Shell [ ] Do not log RW [ ] Monitor DLL Read/Write [ ]
fopen [ ] C:\Users\IEUser\Downloads\stage1\stage1.pdf
temp [✓] C:\Users\IEUser\Downloads\stage1
Manual Arguments

```
000000   3C 3C 2F 53 2F 4A 61 76 61 53 63 72 69 70 74 2F    <</S/JavaScript/
000010   4A 53 28 74 68 69 73 2E 65 78 70 6F 72 74 44 61    JS(this.exportDa
000020   74 61 4F 62 6A 65 63 74 28 7B                      taObject({
```


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Select C:\Windows\SYSTEM32\cmd.exe

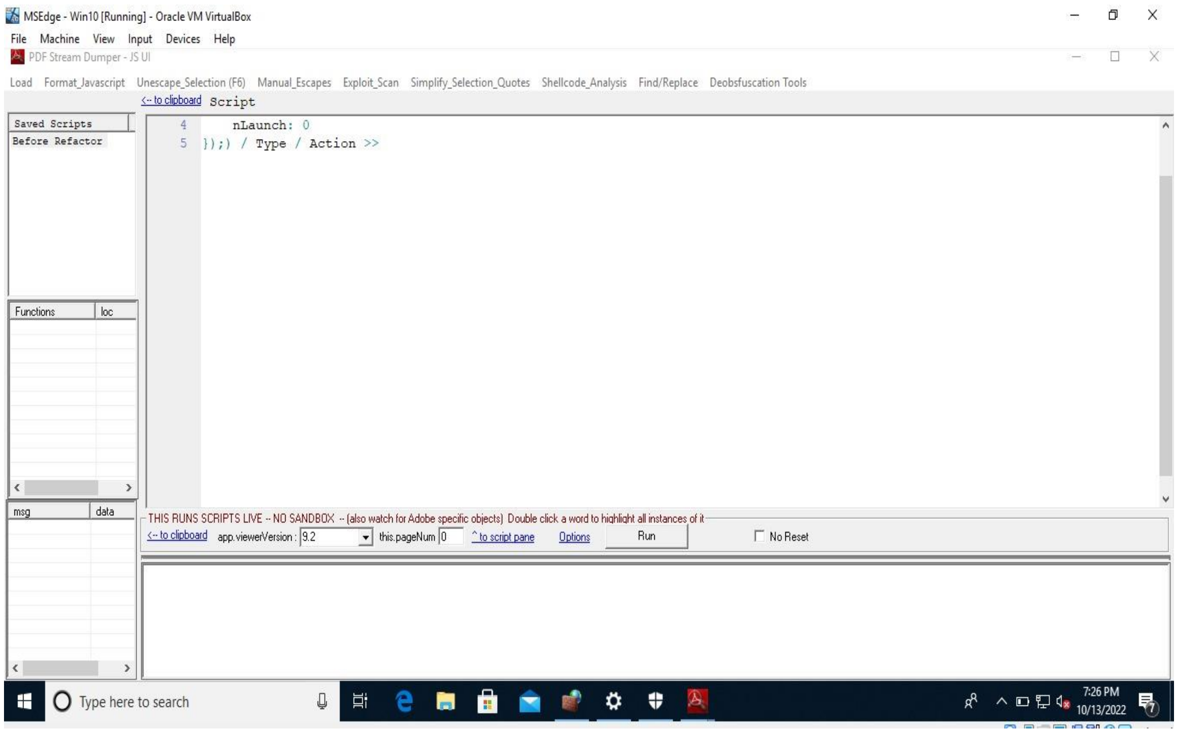
```
/i                    enable interactive hooks (file and network)
/las int              log at step ex. -las 100
/laa hexnum           log at address or api ex. -laa 0x401020 or -laa ReadFile
/lookup api           shows the address of WinAPi function ex. -lookup GetProcAddress
/mm                   enabled Memory Monitor (logs access to key addresses)
/mdll                 Monitor Dll - log direct access to dll memory (hook detection/patches)
/min steps            min number of steps (decimal) to trigger record in findsc mode (def 200)
/nc                   no color (if using sending output to other apps)
/noseh                Disables support for seh and UnhandledExceptionFilter
/norw                 Disables display of read/write file hooks
/o hexnum             base offset to use (default: 0x401000)
/patch fpath          load patch file <fpath> into libemu memory
/r                    show analysis report at end of run (includes -mm)
/redir ip:port        redirect connect to ip (port optional)
/s int                max number of steps to run (def=2000000, -1 unlimited)
/sigs                 show signatures (can be used with -disasm)
/t int                MS to delay between steps (v1-2) or api (v0)
/temp folder          use folder as temp path for interactive mode file writes
/u                    unlimited steps (same as -s -1)
/v                    verbosity, can be used up to 4 times, ex. /v /v /vv
/- /+                 increments or decrements GetFileSize, can be used multiple times
/va 0xBase-0xSize     VirtualAlloc memory at 0xBase of 0xSize
/raw 0xBase-fpath     Raw Patch Mode: load fpath into mem at 0xBase (not PE aware)
/llo dllName-0xBase   LoadLibrary Override: returns 0xBase for LoadLibrary/GetModuleHandle
/wint 0xBase-0xVal    Write 32bit integer 0xValue at 0xBase
/wstr 0xBase-Str      Write string at base ex. 0x401000-0x9090EB15CCBB or "0xBase-ascii string"
/dllmap               show the name, base, size, and version of all built in dlls
/nofile               assumes you have loaded shellcode manually with -raw, -wstr, or -wint
/bswap                byte swaps -f and -wstr input buffers
/eswap                endian swaps -f and -wstr input buffers
/conv path            outputs converted shellcode to file (%u,\x,bswap,eswap..)
/ida                  connects to last opened IDA instance on startup
/[reg] value          sets init register value ex: -eax 0x20 -ebx 20 -ecx base -reg base

 in the dbg> shell enter ? to see supported commands
```


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Select C:\Windows\SYSTEM32\cmd.exe

```
scdbg is an adaption of the libemu library and sctest project
Libemu Copyright (C) 2007  Paul Baecher & Markus Koetter
scdbg developer: David Zimmer <dzzie@yahoo.com>
Compile date: Jun 29 2015 13:05:50

/f fpath              load shellcode from file - accepts binary, %u, \x, %x, hex blob
/api                  scan memory and try to find API table
/auto                 running as part of an automation run
/ba hexnum            break above - breaks if eip > hexnum
/bp varies            set breakpoint on file offset, virtual addr or api name (max 10)
/bs int               break on step (shortcut for -las <int> -vvv)
/b0                   break if 00 00 add [eax],al
/cmd "string data"    data to use for GetCommandLineA (use \" to embed quotes)
/cfo                  CreateFileOverRide - if /fopen use handle else open real arg
/d                    dump unpacked shellcode
/dir  folder          process *.sc in <folder> supports: -r (1 report), -v (report mode), -u
/disasm int           Disasm int lines (can be used with /foff)
/dump                 view hexdump (can be used with /foff)
/e int                verbosity on error (3 = debug shell)
/findsc               detect possible shellcode buffers (brute force) (supports -dump, -disasm)
/fopen file           Opens a handle to <file> for use with GetFileSize() scanners
/foff hexnum          starts execution at file offset (also supports virtual addresses)
/h                    show this help
/hex                  show hex dumps for hook reads/writes (paged)
/hooks                dumps a list all implemented api hooks
/i                    enable interactive hooks (file and network)
/las int              log at step ex. -las 100
/laa hexnum           log at address or api ex. -laa 0x401020 or -laa ReadFile
/lookup api           shows the address of WinAPi function ex. -lookup GetProcAddress
/mm                   enabled Memory Monitor (logs access to key addresses)
/mdll                 Monitor Dll - log direct access to dll memory (hook detection/patches)
/min steps            min number of steps (decimal) to trigger record in findsc mode (def 200)
/nc                   no color (if using sending output to other apps)
/noseh                Disables support for seh and UnhandledExceptionFilter
/norw                 Disables display of read/write file hooks
```

7. Create a shellcode executable.

Answer: The created shellcode is shown below:

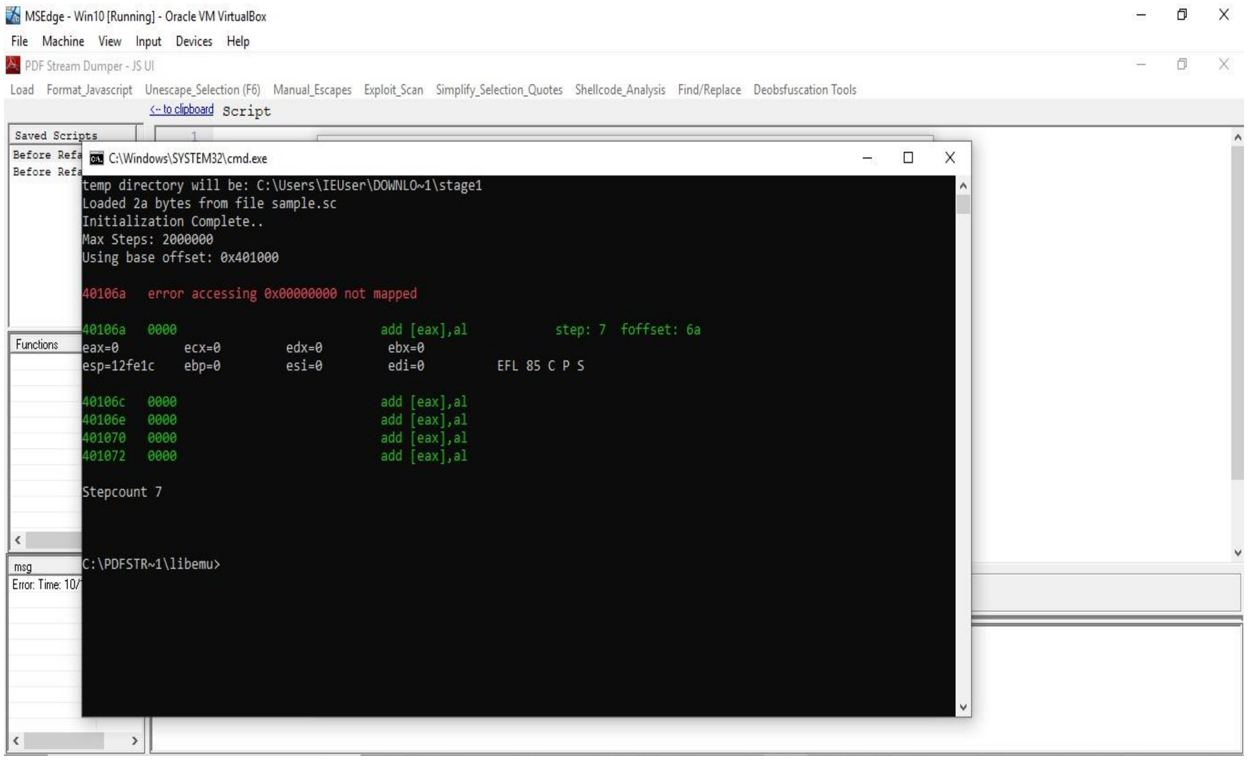


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PDF Stream Dumper - JS UI
Load Format_Javascript Unescape_Selection (F6) Manual_Escapes Exploit_Scan Simplify_Selection_Quotes Shellcode_Analysis Find/Replace Deobsfuscation Tools
Saved Scripts
Before Refactor
Functions
msg
data
Run
No Reset
Type here to search
7:26 PM
10/13/2022

```
    nLaunch: 0
});) / Type / Action >>
```

THIS RUNS SCRIPTS LIVE -- NO SANDBOX -- (also watch for Adobe specific objects) Double click a word to highlight all instances of it

app.viewerVersion : 9.2   this.pageNum 0

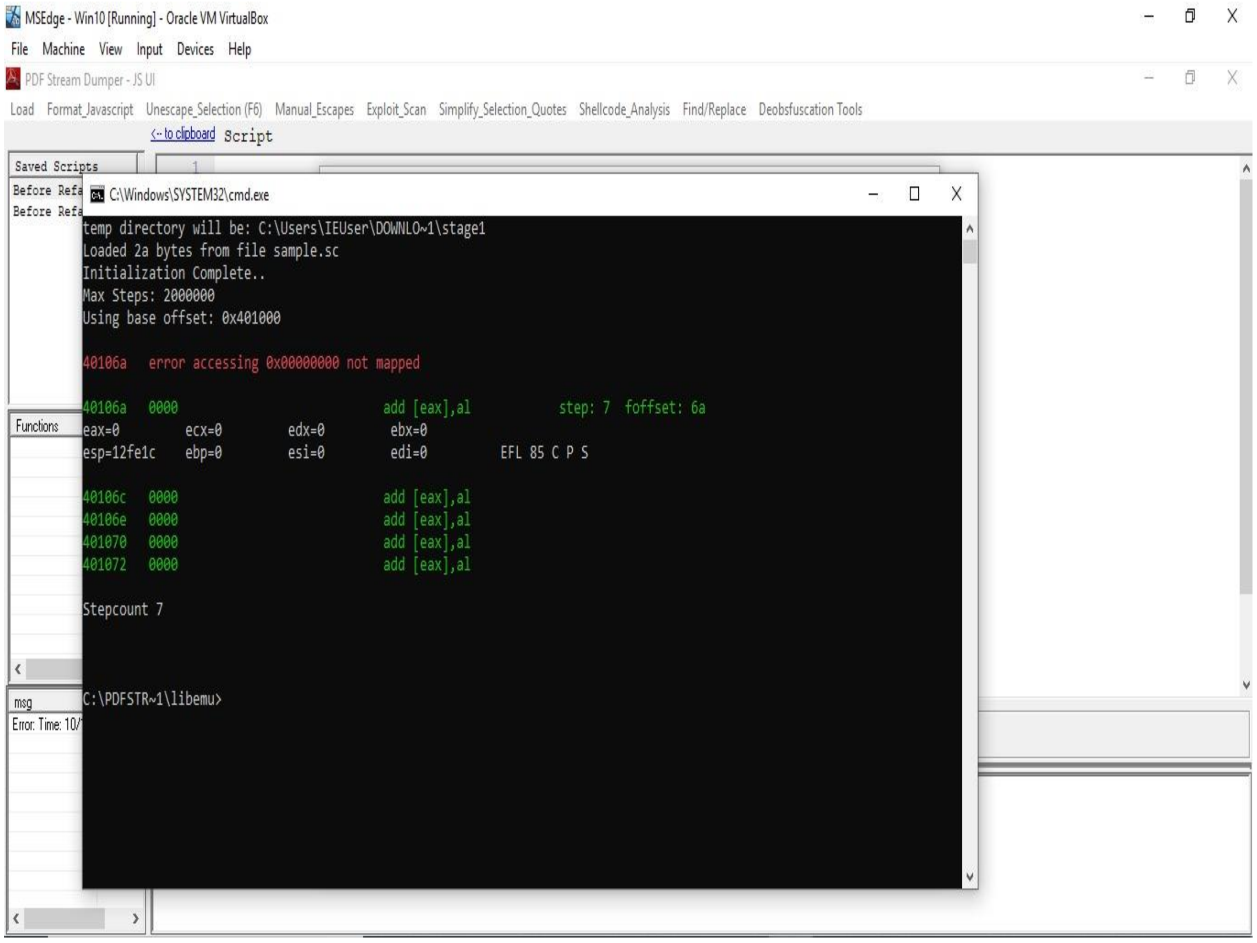


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PDF Stream Dumper - JS UI
Load Format_Javascript Unescape_Selection (F6) Manual_Escapes Exploit_Scan Simplify_Selection_Quotes Shellcode_Analysis Find/Replace Deobsfuscation Tools
C:\Windows\SYSTEM32\cmd.exe

```
temp directory will be: C:\Users\IEUser\DOWNLO~1\stage1
Loaded 2a bytes from file sample.sc
Initialization Complete..
Max Steps: 2000000
Using base offset: 0x401000

40106a   error accessing 0x00000000 not mapped

40106a   0000                         add [eax],al          step: 7  foffset: 6a
eax=0         ecx=0         edx=0         ebx=0
esp=12fe1c    ebp=0         esi=0         edi=0         EFL 85 C P S

40106c   0000                         add [eax],al
40106e   0000                         add [eax],al
401070   0000                         add [eax],al
401072   0000                         add [eax],al

Stepcount 7


C:\PDFSTR~1\libemu>
```

8. Analyze shell code and determine what is does or even execute it using sctest or spider monkey.

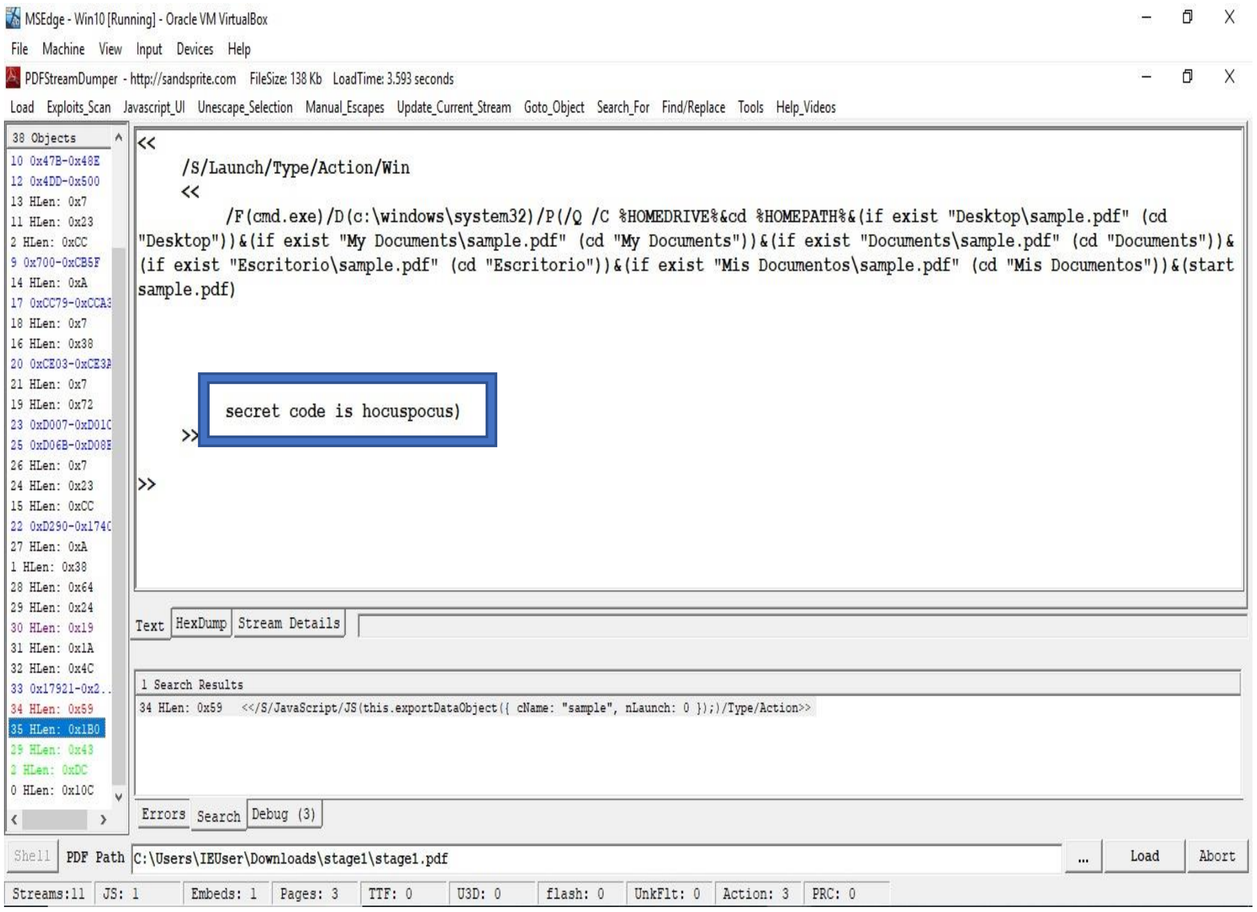
Answer: Before the execution of shell code, we got the data as Ip address, I-port or mac address etc. But due to the change of shell code we get an error.


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PDF Stream Dumper - JS UI
Load Format_Javascript Unescape_Selection (F6) Manual_Escapes Exploit_Scan Simplify_Selection_Quotes Shellcode_Analysis Find/Replace Deobsfuscation Tools
<-- to clipboard Script
Saved Scripts
Functions
msg
C:\Windows\SYSTEM32\cmd.exe

```
temp directory will be: C:\Users\IEUser\DOWNLO~1\stage1
Loaded 2a bytes from file sample.sc
Initialization Complete..
Max Steps: 2000000
Using base offset: 0x401000

40106a   error accessing 0x00000000 not mapped

40106a   0000                         add [eax],al          step: 7  foffset: 6a
eax=0        ecx=0        edx=0        ebx=0
esp=12fe1c   ebp=0        esi=0        edi=0         EFL 85 C P S

40106c   0000                         add [eax],al
40106e   0000                         add [eax],al
401070   0000                         add [eax],al
401072   0000                         add [eax],al

Stepcount 7



C:\PDFSTR~1\libemu>
```

9. What is the secret code?

Answer: The secret code is hocuspocus.


MSEdge - Win10 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
PDFStreamDumper - http://sandsprite.com FileSize: 138 Kb LoadTime: 3.593 seconds
Load Exploits_Scan Javascript_UI Unescape_Selection Manual_Escapes Update_Current_Stream Goto_Object Search_For Find/Replace Tools Help_Videos

```
38 Objects
10 0x47B-0x48E
12 0x4DD-0x500
13 HLen: 0x7
11 HLen: 0x23
2 HLen: 0xCC
9 0x700-0xCB5F
14 HLen: 0xA
17 0xCC79-0xCCA3
18 HLen: 0x7
16 HLen: 0x38
20 0xCE03-0xCE3A
21 HLen: 0x7
19 HLen: 0x72
23 0xD007-0xD01C
25 0xD06B-0xD08E
26 HLen: 0x7
24 HLen: 0x23
15 HLen: 0xCC
22 0xD290-0x174C
27 HLen: 0xA
1 HLen: 0x38
28 HLen: 0x64
29 HLen: 0x24
30 HLen: 0x19
31 HLen: 0x1A
32 HLen: 0x4C
33 0x17921-0x2..
34 HLen: 0x59
35 HLen: 0x1B0
29 HLen: 0x43
3 HLen: 0xDC
0 HLen: 0x10C
```

```
<<
     /S/Launch/Type/Action/Win
     <<
          /F(cmd.exe)/D(c:\windows\system32)/P(/Q /C %HOMEDRIVE%&cd %HOMEPATH%&(if exist "Desktop\sample.pdf" (cd
"Desktop"))&(if exist "My Documents\sample.pdf" (cd "My Documents"))&(if exist "Documents\sample.pdf" (cd "Documents"))&
(if exist "Escritorio\sample.pdf" (cd "Escritorio"))&(if exist "Mis Documentos\sample.pdf" (cd "Mis Documentos"))&(start
sample.pdf)



        secret code is hocuspocus)
     >>

>>
```

```
1 Search Results
34 HLen: 0x59   <</S/JavaScript/JS(this.exportDataObject({ cName: "sample", nLaunch: 0 });)/Type/Action>>
```

```
C:\Users\IEUser\Downloads\stage1\stage1.pdf
Streams:11  JS: 1  Embeds: 1  Pages: 3  TTF: 0  U3D: 0  flash: 0  UnkFlt: 0  Action: 3  PRC: 0
```