LAB 3 MANUAL

Name : keerthan pv
SRN : PES2UG23CS272

In every screenshot make sure your SRN is present

This lab needs to be executed in your VM or Linux machine as /dev/random or /dev/urandom are Unix/Linux-specific device files

Task 1

- Provide both the completed code and an output screenshot with the corresponding SRN clearly displayed.
- Ensure that all sub-questions are answered comprehensively.


```
[09/09/25]seed@keerthanpv:~/Documents$ python3 pes2ug23cs272_task1.py
Current timestamp: 1757476762
Generated key (hex): ec82bf72e56475611e095d26e0e80a48
--------------------------------------------------
Current timestamp: 1757476763
Generated key (hex): 01afcfad80cfa608912bb969b14aae84
--------------------------------------------------
Current timestamp: 1757476764
Generated key (hex): f59310400571704310212758 6f057eb4
--------------------------------------------------
```

1. Why do the keys repeat when generated multiple times close together?

The random number generator is being seeded with the current time in seconds. Since the seed only changes once every second, if you generate two keys within the same second, the program starts from the same seed and

produces the exact same sequence of numbers. That's why the keys sometimes repeat when created too close together.

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2. What is the security risk if an attacker knows the rough time of key generation?

If someone has a good guess of when the key was generated (for example, the attacker knows you ran the program around 3:15:06 PM), they don't need to try all 2^{128} possible keys. Instead, they can just try all the seeds around that second — maybe a few hundred or thousand guesses at most. This makes the key much easier to crack.

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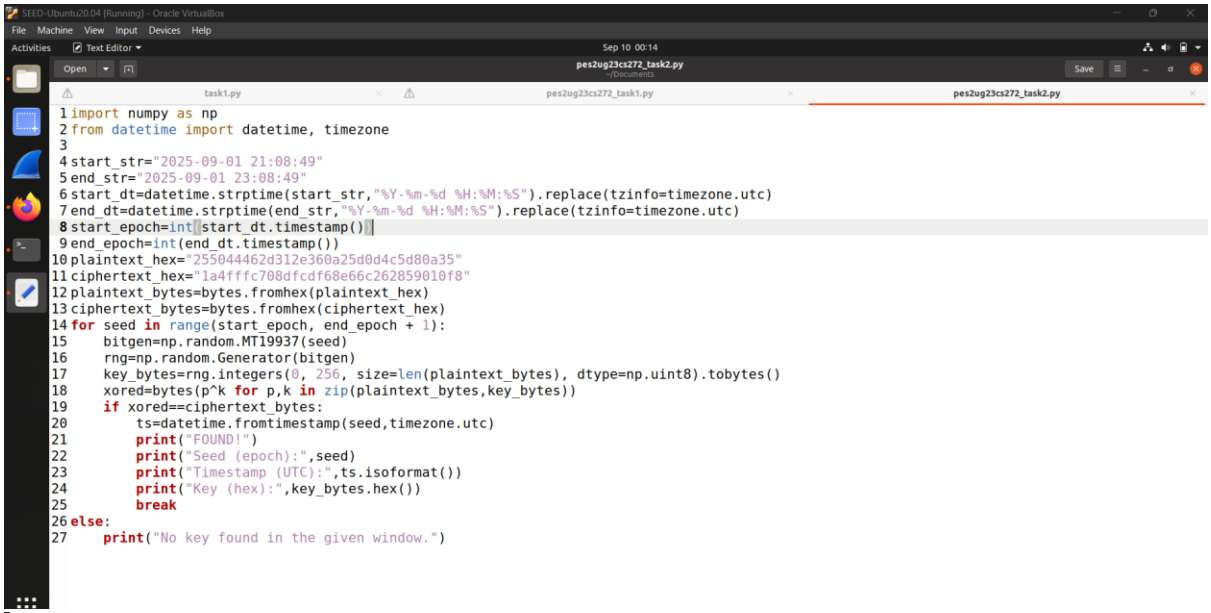
3. How does seeding with the timestamp waste the 128-bit potential and fail to maximize randomness?

A true 128-bit key has an enormous number of possibilities — about 3.4×10^{38}. That's practically impossible to brute-force. But when the seed comes from the system time, the possibilities are limited to the number of seconds since 1970 — only around 2^{32} different values. So instead of using the full strength of 128-bit randomness, the actual randomness comes from just a few billion possibilities. That's tiny in comparison, and it makes the keys predictable and insecure.

Task 2

- Complete the given code and provide both the completed code and an output screenshot with the corresponding SRN clearly displayed.
- Ensure that all sub-questions are answered comprehensively.




```
[09/10/25]seed@keerthanpv:~/Documents$ python3 pes2ug23cs272_task2.py
FOUND!
Seed (epoch): 1756761334
Timestamp (UTC): 2025-09-01T21:15:34+00:00
Key (hex): 3f1fbb8125eee3c0844312b640481acd
[09/10/25]seed@keerthanpv:~/Documents$
```

Task 3

- Complete the given code and provide both the completed code and an output screenshot with the corresponding SRN clearly displayed.
- Ensure that all sub-questions are answered comprehensively.

1. Which method is usually the slowest, and why doesn't it always act that way?

/dev/random is usually the slowest because it can stop (block) and wait for real randomness from things like keyboard presses or disk activity. But if the system already has lots of randomness stored, it won't need to wait, so it can sometimes be just as fast.

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2. What's the main difference between /dev/random and /dev/urandom?

- /dev/random waits until it has "fresh" randomness before giving you data.
- /dev/urandom never waits — it uses a strong algorithm to stretch existing randomness so it can always give you output immediately.

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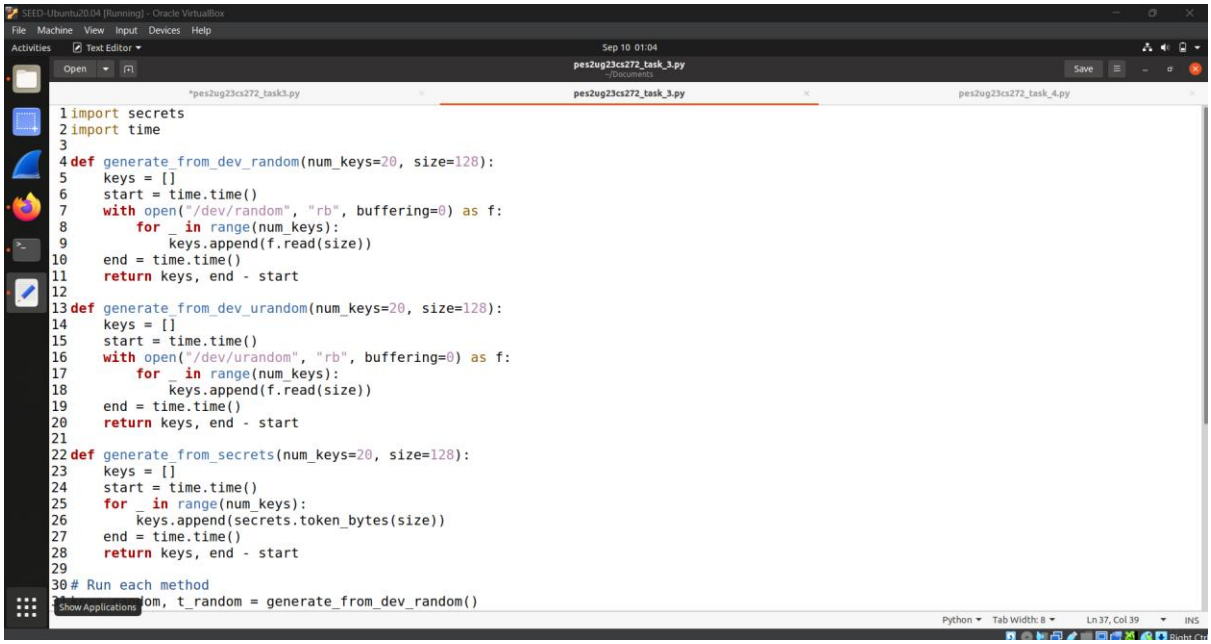
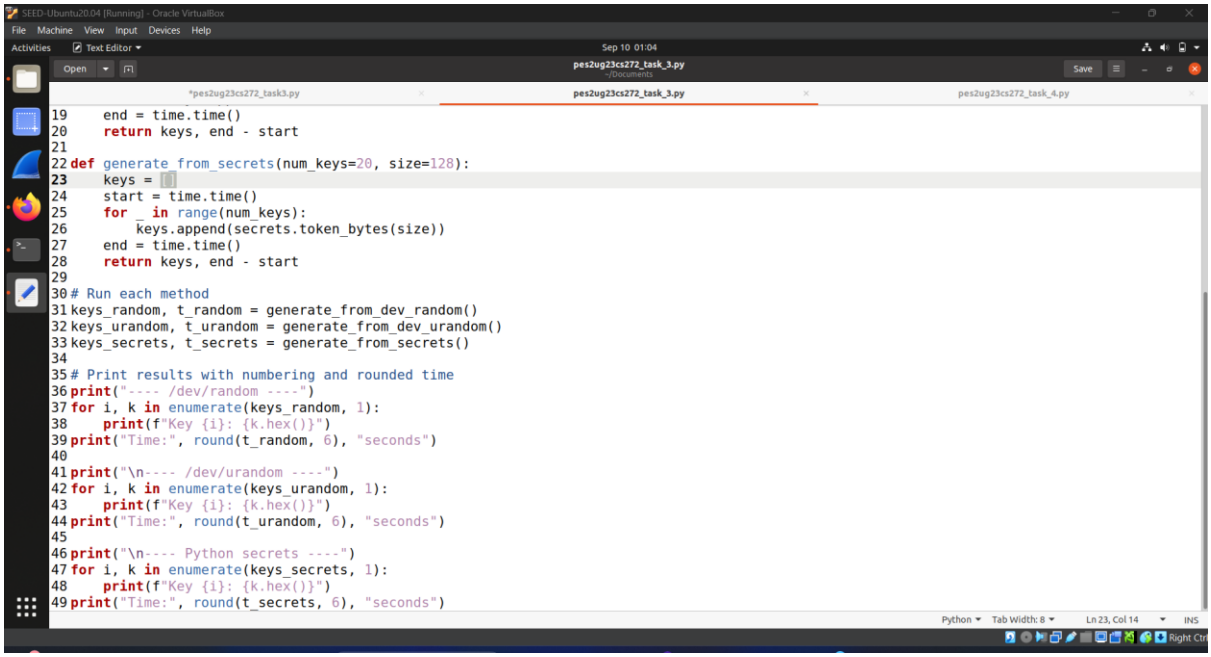
3. Which method does Python's secrets module use?

The secrets module uses whatever secure random source the operating system provides. On Linux, this is /dev/urandom. On Windows, it uses the system's secure random functions.

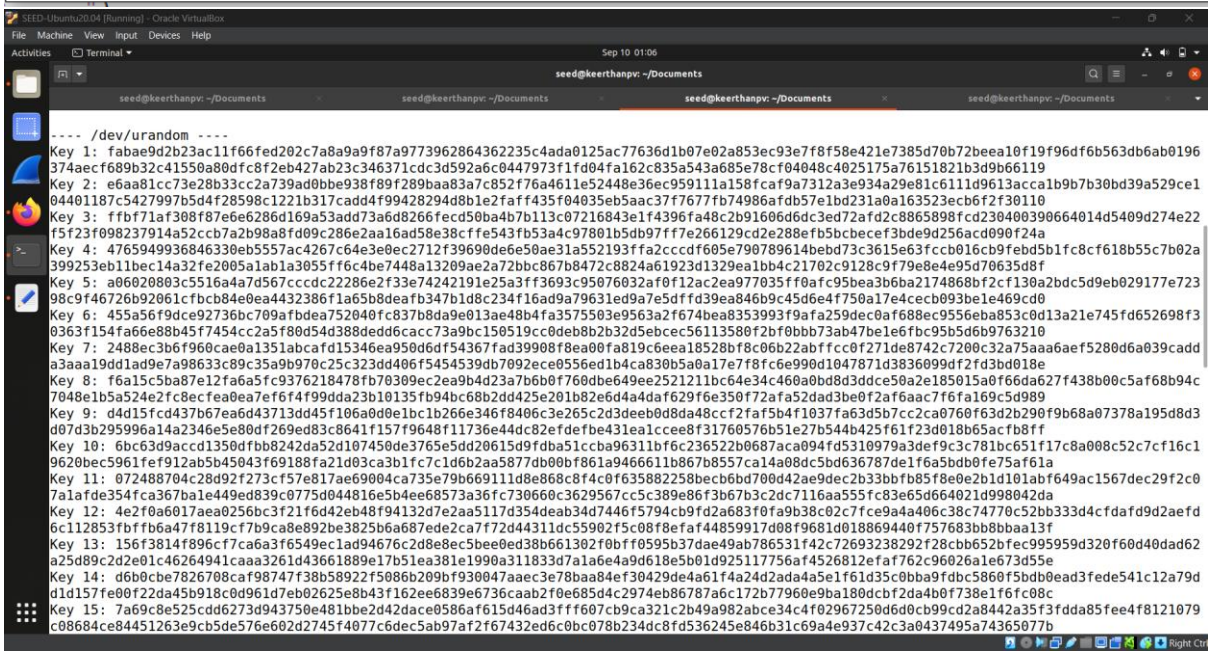


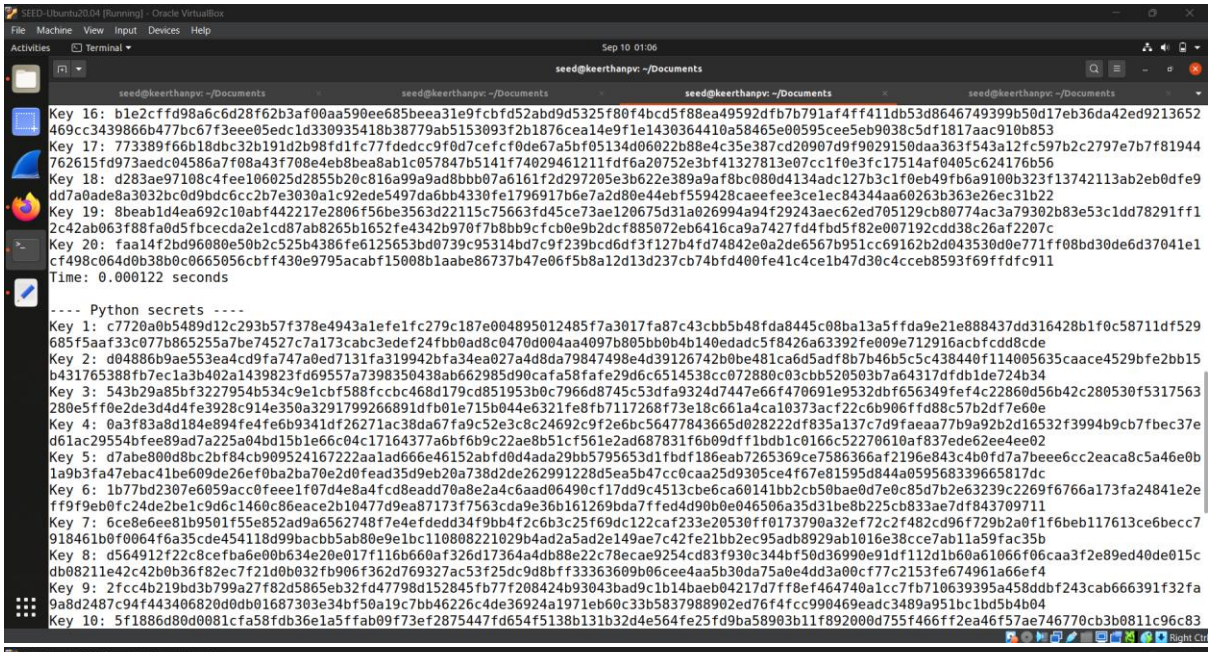
```python
import secrets
import time

def generate_from_dev_random(num_keys=20, size=128):
    keys = []
    start = time.time()
    with open("/dev/random", "rb", buffering=0) as f:
        for _ in range(num_keys):
            keys.append(f.read(size))
    end = time.time()
    return keys, end - start

def generate_from_dev_urandom(num_keys=20, size=128):
    keys = []
    start = time.time()
    with open("/dev/urandom", "rb", buffering=0) as f:
        for _ in range(num_keys):
            keys.append(f.read(size))
    end = time.time()
    return keys, end - start

def generate_from_secrets(num_keys=20, size=128):
    keys = []
    start = time.time()
    for _ in range(num_keys):
        keys.append(secrets.token_bytes(size))
    end = time.time()
    return keys, end - start

# Run each method
om, t_random = generate_from_dev_random()
```



```python
    end = time.time()
    return keys, end - start

def generate_from_secrets(num_keys=20, size=128):
    keys = []
    start = time.time()
    for _ in range(num_keys):
        keys.append(secrets.token_bytes(size))
    end = time.time()
    return keys, end - start

# Run each method
keys_random, t_random = generate_from_dev_random()
keys_urandom, t_urandom = generate_from_dev_urandom()
keys_secrets, t_secrets = generate_from_secrets()

# Print results with numbering and rounded time
print("---- /dev/random ----")
for i, k in enumerate(keys_random, 1):
    print(f"Key {i}: {k.hex()}")
print("Time:", round(t_random, 6), "seconds")

print("\n---- /dev/urandom ----")
for i, k in enumerate(keys_urandom, 1):
    print(f"Key {i}: {k.hex()}")
print("Time:", round(t_urandom, 6), "seconds")

print("\n---- Python secrets ----")
for i, k in enumerate(keys_secrets, 1):
    print(f"Key {i}: {k.hex()}")
print("Time:", round(t_secrets, 6), "seconds")
```

```
seed@keerthanpv: ~/Do...   seed@keerthanpv: ~/Do...   seed@keerthanpv: ~/Do...   seed@keerthanpv: ~/Do...
[09/10/25]seed@keerthanpv:~/Documents$ touch pes2ug23cs272_task_3.py
[09/10/25]seed@keerthanpv:~/Documents$ python3 pes2ug23cs272_task_3.py
---- /dev/random ----
Key 1: 696ae9d862de
Key 2: 3ee620ffa890
Key 3: c0f6a11a4758
Key 4: 66d76b0c8d04
Key 5: 876820057bc3
Key 6: 529b4a6d57e2
Key 7: 5529338a4d43
Key 8: 56517cec3dce
Key 9: 965f28e83583
Key 10: 4f28e610d631
Key 11: 162a44ba465c
Key 12: 899ff79b31db
Key 13: 39e46b6c687c
Key 14: 9b0ed86fe743
Key 15: a252f3c6b39f
Key 16: c30b44064903
Key 17: bcaa9f0739f1
Key 18: 798a79d2b988
Key 19: af55e3b8c267
Key 20: 7fae0338fc9a
Time: 171.902025 seconds
```





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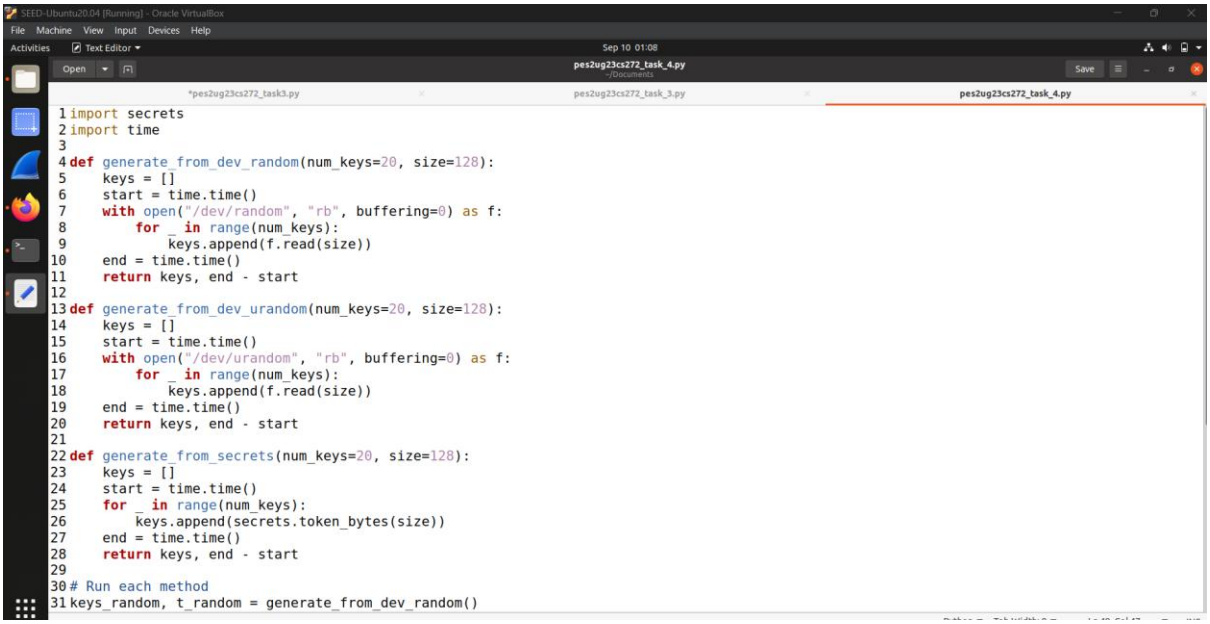
4. When would you use /dev/random instead of /dev/urandom?

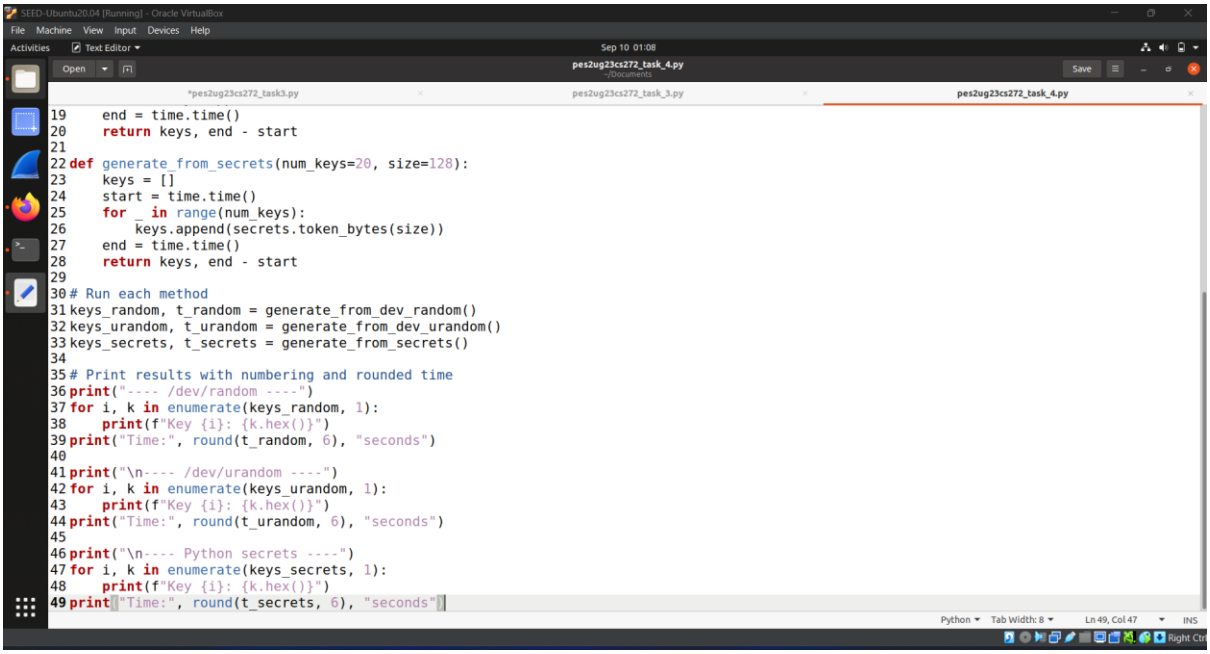
You'd only use /dev/random when you need the very best randomness possible, like creating a very long-term encryption key. For most normal use cases, /dev/urandom or Python's secrets is better, because they're secure enough and don't get stuck waiting.

Task4

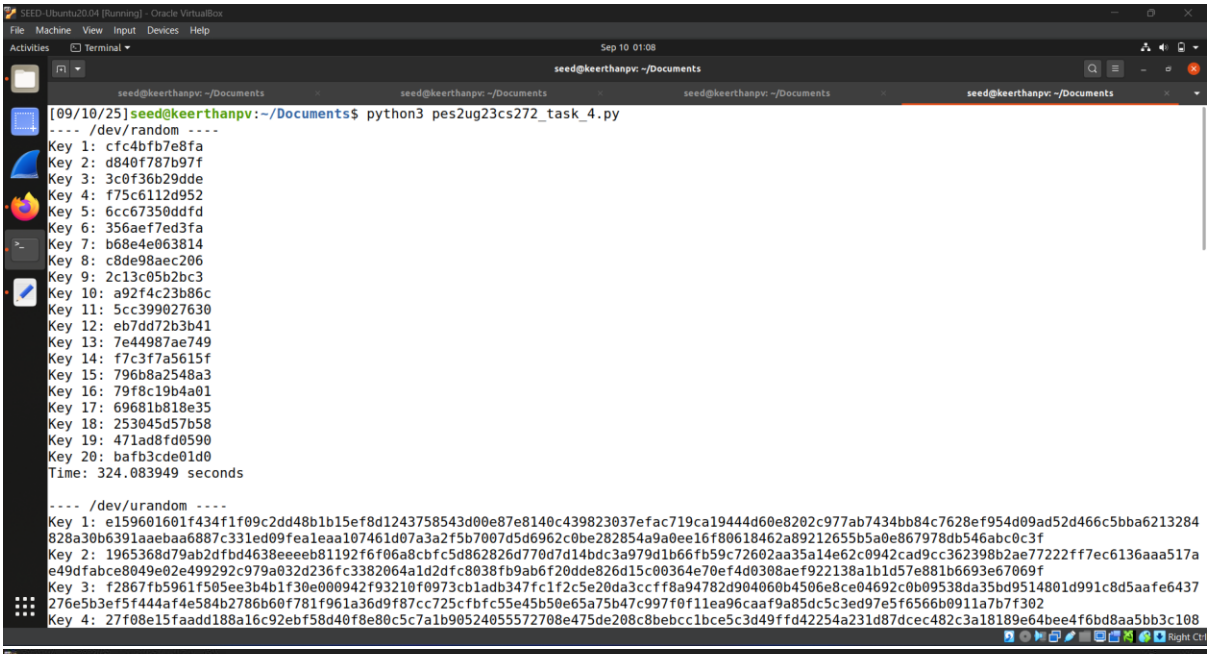
- Complete the given code and provide both the completed code and an output screenshot with the corresponding SRN clearly displayed.
- Ensure that all sub-questions are answered comprehensively.



```python
import secrets
import time

def generate_from_dev_random(num_keys=20, size=128):
    keys = []
    start = time.time()
    with open("/dev/random", "rb", buffering=0) as f:
        for _ in range(num_keys):
            keys.append(f.read(size))
    end = time.time()
    return keys, end - start

def generate_from_dev_urandom(num_keys=20, size=128):
    keys = []
    start = time.time()
    with open("/dev/urandom", "rb", buffering=0) as f:
        for _ in range(num_keys):
            keys.append(f.read(size))
    end = time.time()
    return keys, end - start

def generate_from_secrets(num_keys=20, size=128):
    keys = []
    start = time.time()
    for _ in range(num_keys):
        keys.append(secrets.token_bytes(size))
    end = time.time()
    return keys, end - start

# Run each method
keys_random, t_random = generate_from_dev_random()
```



```python
    end = time.time()
    return keys, end - start

def generate_from_secrets(num_keys=20, size=128):
    keys = []
    start = time.time()
    for _ in range(num_keys):
        keys.append(secrets.token_bytes(size))
    end = time.time()
    return keys, end - start

# Run each method
keys_random, t_random = generate_from_dev_random()
keys_urandom, t_urandom = generate_from_dev_urandom()
keys_secrets, t_secrets = generate_from_secrets()

# Print results with numbering and rounded time
print("---- /dev/random ----")
for i, k in enumerate(keys_random, 1):
    print(f"Key {i}: {k.hex()}")
print("Time:", round(t_random, 6), "seconds")

print("\n---- /dev/urandom ----")
for i, k in enumerate(keys_urandom, 1):
    print(f"Key {i}: {k.hex()}")
print("Time:", round(t_urandom, 6), "seconds")

print("\n---- Python secrets ----")
for i, k in enumerate(keys_secrets, 1):
    print(f"Key {i}: {k.hex()}")
print("Time:", round(t_secrets, 6), "seconds")
```


SEED-Ubuntu20.04 [Running] - Oracle VirtualBox
File Machine View Input Devices Help
Activities Terminal Sep 10 01:08
seed@keerthanpv: ~/Documents
seed@keerthanpv: ~/Documents
seed@keerthanpv: ~/Documents
seed@keerthanpv: ~/Documents
seed@keerthanpv: ~/Documents
[09/10/25]seed@keerthanpv:~/Documents$ python3 pes2ug23cs272_task_4.py
---- /dev/random ----
Key 1: cfc4bfb7e8fa
Key 2: d840f787b97f
Key 3: 3c0f36b29dde
Key 4: f75c6112d952
Key 5: 6cc67350ddfd
Key 6: 356aef7ed3fa
Key 7: b68e4e063814
Key 8: c8de98aec206
Key 9: 2c13c05b2bc3
Key 10: a92f4c23b86c
Key 11: 5cc399027630
Key 12: eb7dd72b3b41
Key 13: 7e44987ae749
Key 14: f7c3f7a5615f
Key 15: 796b8a2548a3
Key 16: 79f8c19b4a01
Key 17: 69681b818e35
Key 18: 253045d57b58
Key 19: 471ad8fd0590
Key 20: bafb3cde01d0
Time: 324.083949 seconds
---- /dev/urandom ----
Key 1: e159601601f434f1f09c2dd48b1b15ef8d1243758543d00e87e8140c439823037efac719ca19444d60e8202c977ab7434bb84c7628ef954d09ad52d466c5bba6213284
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Key 2: 1965368d79ab2dfbd4638eeeeb81192f6f06a8cbfc5d862826d770d7d14bdc3a979d1b66fb59c72602aa35a14e62c0942cad9cc362398b2ae77222ff7ec6136aaa517a
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Key 3: f2867fb5961f505ee3b4b1f30e000942f93210f0973cb1adb347fc1f2c5e20da3ccff8a94782d904060b4506e8ce04692c0b09538da35bd9514801d991c8d5aafe6437
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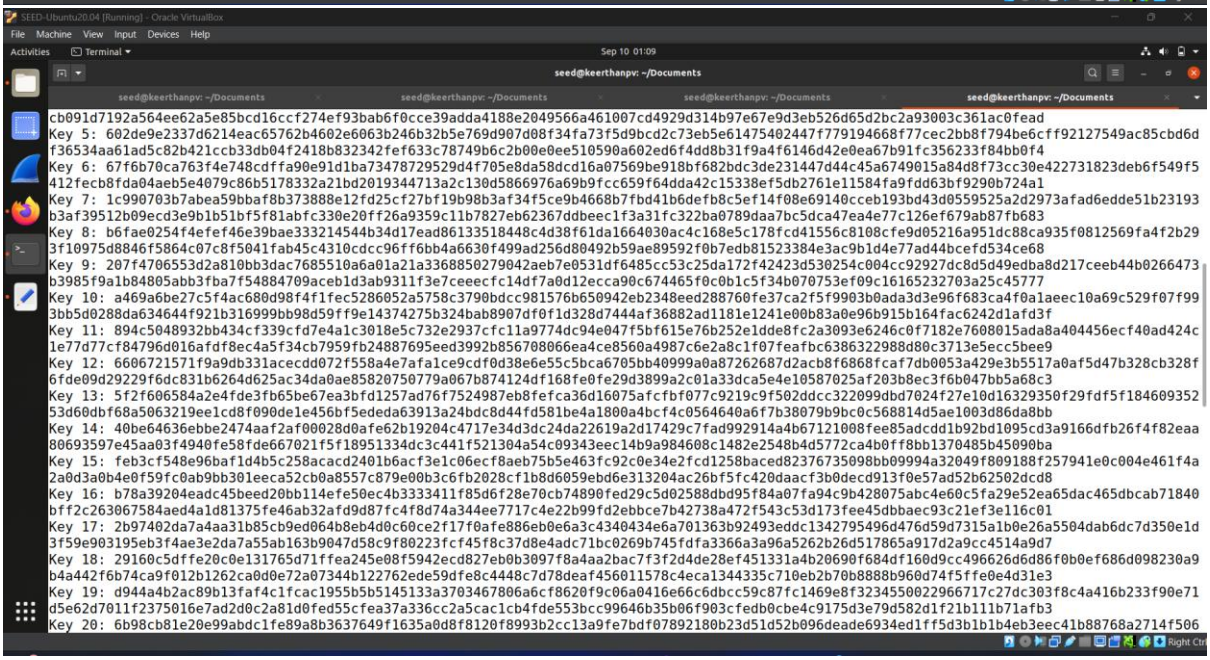
Key 4: 27f08e15faadd188a16c92ebf58d40f8e80c5c7a1b90524055572708e475de208c8bebcc1bce5c3d49ffd42254a231d87dcec482c3a18189e64bee4f6bd8aa5bb3c108
Right Ctrl


SEED-Ubuntu20.04 [Running] - Oracle VirtualBox
File Machine View Input Devices Help
Activities Terminal Sep 10 01:09
seed@keerthanpv: ~/Documents
seed@keerthanpv: ~/Documents
seed@keerthanpv: ~/Documents
seed@keerthanpv: ~/Documents
seed@keerthanpv: ~/Documents
cb091d7192a564ee62a5e85bcd16ccf274ef93bab6f0cce39adda4188e2049566a461007cd4929d314b97e67e9d3eb526d65d2bc2a93003c361ac0fead
Key 5: 602de9e2337d6214eac65762b4602e6063b246b32b5e769d907d08f34fa73f5d9bcd2c73eb5e61475402447f779194668f77cec2bb8f794be6cff92127549ac85cbd6d
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Key 6: 67f6b70ca763f4e748cdffa90e91d1ba73478729529d4f705e8da58dcd16a07569be918bf682bdc3de231447d44c45a6749015a84d8f73cc30e422731823deb6f549f5
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Key 7: 1c990703b7abea59bbaf8b373888e12fd25cf27bf19b98b3af34f5ce9b4668b7fbd41b6defb8c5ef14f08e69140cceb193bd43d0559525a2d2973afad6edde51b23193
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Key 8: b6fae0254f4efef46e39bae33214544b34d17ead86133518448c4d38f61da1664030ac4c168e5c178fcd41556c8108cfe9d05216a951dc88ca935f0812569fa4f2b29
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Key 9: 207f4706553d2a810bb3dac7685510a6a01a21a3368850279042aeb7e0531df6485cc53c25da172f42423d530254c004cc92927dc8d5d49edba8d217ceeb44b0266473
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Key 10: a469a6be27c5f4ac680d98f4f1fec5286052a5758c3790bdcc981576b650942eb2348eed288760fe37ca2f5f9903b0ada3d3e96f683ca4f0a1aeec10a69c529f07f99
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Key 11: 894c5048932bb434cf339cfd7e4a1c3018e5c732e2937cfc11a9774dc94e047f5bf615e76b252e1dde8fc2a3093e6246c0f7182e7608015ada8a404456ecf40ad424c
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Key 13: 5f2f606584a2e4fde3fb65be67ea3bfd1257ad76f7524987eb8fefca36d16075afcfbf077c9219c9f502ddcc322099dbd7024f27e10d16329350f29fdf5f184609352
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Key 14: 40be64636ebbe2474aaf2af00028d0afe62b19204c4717e34d3dc24da22619a2d17429c7fad992914a4b67121008fee85adcdd1b92bd1095cd3a9166dfb26f4f82eaa
80693597e45aa03f4940fe58fde667021f5f18951334dc3c441f521304a54c09343eec14b9a984608c1482e2548b4d5772ca4b0ff8bb1370485b45090ba
Key 15: feb3cf548e96baf1d4b5c258acacd2401b6acf3e1c06ecf8aeb75b5e463fc92c0e34e2fcd1258baced82376735098bb09994a32049f809188f257941e0c004e461f4a
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Key 17: 2b97402da7a4aa31b85cb9ed064b8eb4d0c60ce2f17f0afe886eb0e6a3c4340434e6a701363b92493eddc1342795496d476d59d7315a1b0e26a5504dab6dc7d350e1d
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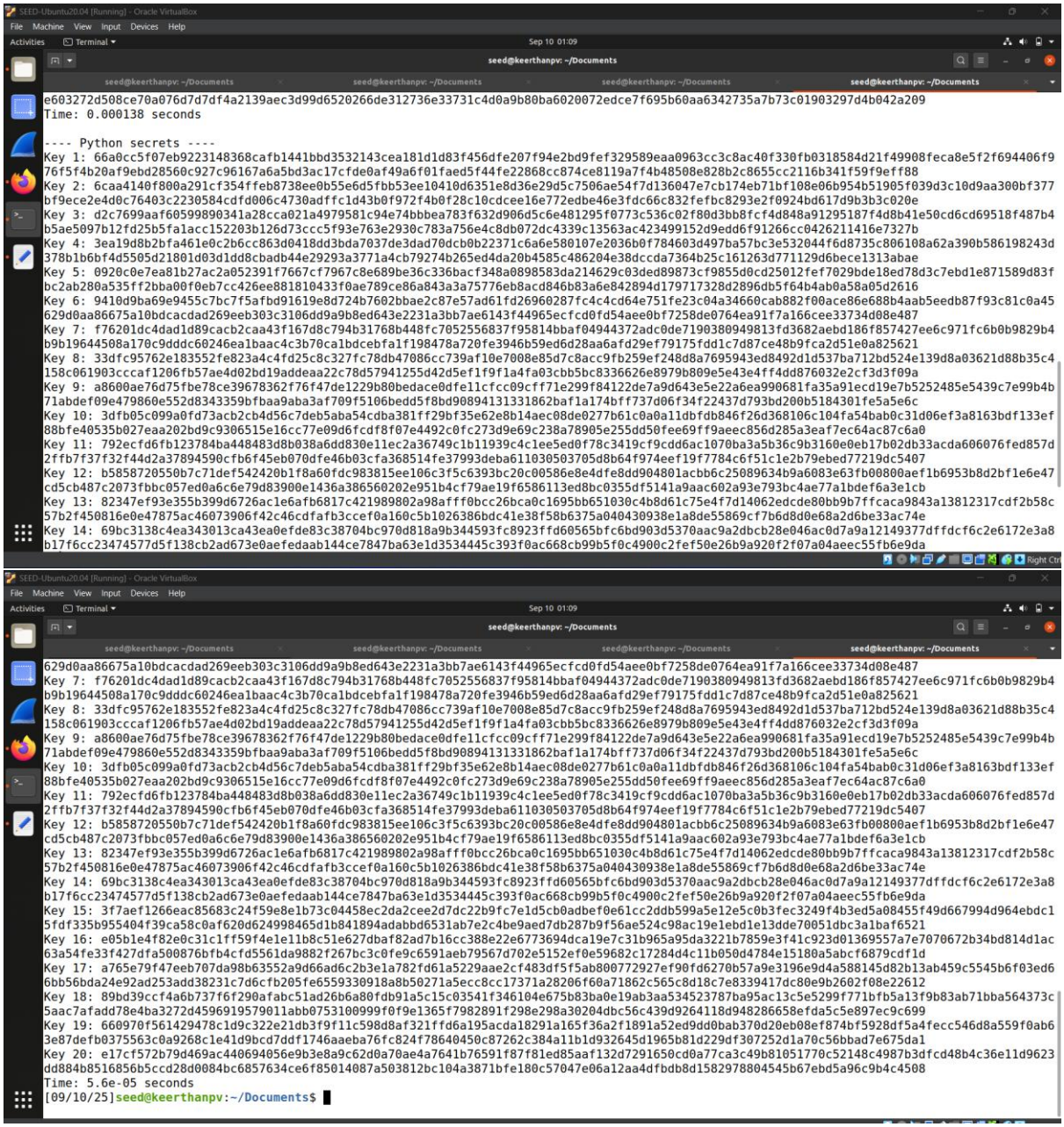
Key 18: 29160c5dffe20c0e131765d71ffea245e08f5942ecd827eb0b3097f8a4aa2bac7f3f2d4de28ef451331a4b20690f684df160d9cc496626d6d86f0b0ef686d098230a9
b4a442f6b74ca9f012b1262ca0d0e72a07344b122762ede59dfe8c4448c7d78deaf456011578c4eca1344335c710eb2b70b8888b960d74f5ffe0e4d31e3
Key 19: d944a4b2ac89b13faf4c1fcac1955b5b5145133a3703467806a6cf8620f9c06a0416e66c6dbcc59c87fc1469e8f32345500229667l7c27dc303f8c4a416b233f90e71
d5e62d7011f2375016e7ad2d0c2a81d0fed55cfea37a336cc2a5cac1cb4fde553bcc99646b35b06f903cfedb0cbe4c9175d3e79d582d1f21b111b71afb3
Key 20: 6b98cb81e20e99abdc1fe89a8b3637649f1635a0d8f8120f8993b2cc13a9fe7bdf07892180b23d51d52b096deade6934ed1ff5d3b1b1b4eb3eec41b88768a2714f506
Right Ctrl



1. Which sources have the highest entropy?

/dev/random, /dev/urandom, and Python's secrets all give very high entropy, almost the maximum (~8 bits/byte). The test patterns and all-zeros are much lower.

2. Why is /dev/urandom faster but still as good?

/dev/random waits for real hardware noise, so it's slow. /dev/urandom uses a secure algorithm to stretch that noise into more random data, so it's fast but still gives nearly the same randomness.