R&D LAB: Competences test

Python:

1. Given an array of numbers representing the stock prices of a company in chronological order, write a function that calculates the maximum profit you could have made from buying and selling that stock once. You must buy before you can sell it. For example, given [9, 11, 8, 5, 7, 10], you should return 5, since you could buy the stock at 5 dollars and sell it at 10 dollars.

```
def maxProfit(stockPrices = []):
buy = min(stockPrices)
buyIndex = stockPrices.index(buy)
profit = []
for i in range(buyIndex + 1, len(stockPrices)):
        profit.append(stockPrices[i] - buy)
    #print(profit)
    maxProfit = max(profit)
    return maxProfit
maxProfit([9, 11, 8, 5, 7, 10])
```

2. Given a string of round, curly, and square open and closing brackets, return whether the brackets are balanced (well-formed). For example, given the string "([])[]({})", you should return true. Given the string "([)]" or "((()", you should return false.

```
def bracketsBalanced(s):
    stack = []
    mapping = {')': '(', '}': '{', ']': '['}

    for char in s:
        if char in '([{':
            stack.append(char)
        elif char in ')]}':
            if not stack or stack[-1] != mapping[char]:
                return False
            stack.pop()

    return len(stack) == 0

bracketsBalanced('([])[{}]({})')
```

3. Given a string, determine whether any permutation of it is a palindrome. For example, carrace should return true, since it can be rearranged to form racecar, which is a palindrome. daily should return false, since there's no rearrangement that can form a palindrome.

```
def palindrome(s):
```

```python
    sPermute = s
    for i in range(0, len(s)):
        sPermute = sPermute[-1] + sPermute[:-1]
        sPalindrome = sPermute[::-1]
        #print(sPermute, sPalindrome)
        if sPermute == sPalindrome:
            return True
        else:
            continue
    return False

palindrome('daily')
```

4. Given an array of numbers and a number k, determine if there are two entries in the array which add up to the specified number k. For example, given [10, 15, 20, 25, 30] and k = 40, return true as 30+10=40.

```python
def add(array, k):
    for i in array:
        for j in array:
            if (i + j) == k:
                return True
    return False
```

5. Given an array of time intervals (start, end) for classroom lectures (possibly overlapping), find the minimum number of rooms required. For example, given [(30, 75), (0, 50), (60, 150)], you should return 2.

```python
def min_meeting_rooms(intervals):
    if not intervals:
        return 0

    intervals.sort(key=lambda x: x[0])  # Sort intervals by start
time
    min_heap = [intervals[0][1]]  # Initialize a heap with the
end time of the first interval
    #print(min_heap)

    for i in range(1, len(intervals)):
        if intervals[i][0] >= min_heap[0]:
            heapq.heappop(min_heap)  # Remove the earliest ending
interval from the heap
        heapq.heappush(min_heap, intervals[i][1])  # Add the
current interval's end time to the heap

    return len(min_heap)
```

```
min_meeting_rooms([(30, 75), (0, 50), (60, 150)])
```

6. Given a multiset of integers, return whether it can be partitioned into two subsets whose sums are the same. For example, given the multiset {15, 5, 20, 10, 35, 15, 10}, it would return true, since we can split it up into {15, 5, 10, 15, 10} and {20, 35}, which both add up to 55. Given the multiset {15, 5, 20, 10, 35}, it would return false, since we can't split it up into two subsets that add up to the same sum.

```python
def multisetPartitioned(nums):
    total_sum = sum(nums)
    if total_sum % 2 != 0:
        return False

    target_sum = total_sum // 2
    dp = [False] * (target_sum + 1)
    dp[0] = True

    for num in nums:
        for i in range(target_sum, num - 1, -1):
            dp[i] = dp[i] or dp[i - num]

    return dp[target_sum]

multisetPartitioned([15, 5, 20, 10, 35])
```

The multiset {15, 5, 20, 10, 35, 15, 10} is not valid for a set, as sets do not allow duplicate values. To accommodate this collection of numbers, I have changed the structure from a set to a list.

Linux:

1. Assume below xml is present in Linux as a file (say Test.xml)

<?xml version='1.0' encoding = 'UTF-8' standalone = 'no' ?>

<content>

<tag1> 426</tag1>

<tag2> 800</tag2>

<tag3> 200</tag3>

</content>

Please mention a command to change value of tag1 to 500.

sed -i 's|<tag1>.*</tag1>|<tag1> 500</tag1>|' Test.xml. This is an Stream Editor

2. Write a code to output the contents of a directory and assume the output of the contents of have colored outputs. Write a command to suppress the output colors and display the results in plain black and white.

ls --color=never /path/to/directory

3. How to kill a Linux process? Mention command.

kill PID or pkill process_name

4. Given a file abx.txt which is present in Linux system, but the user does not know in which directory the file exists. Write a Linux command that prints the location (directory) of the file.

find / -name "abx.txt" 2>/dev/null. Find is the command, / is the starting search path, -name is the file name and the 2>/dev/null will suppress some error logs

5. How to run a command in background mode?

command_to_run &. Add a & to run a process in the background

Radiofrequency:

1. We are measuring different power levels with a power meter at the RF output of a system. What is the correspondence in watts for the following powers?

a. 20 dBm = 0.1 W

b. 0 dBW = 0.001 W

c. 36 dBm = 3.98 W

d. 47 dBm = 50.12 W

2. We need to test a RF power Amplifier. What are the main parameters you think that should be tested in a lab environment?

The main important parameters to test when evaluating an RF power amplifier:

a. **Gain and Gain Flatness:** The gain of an amplifier indicates how much if amplifies an input signal. It's crucial to ensure that the amplifier provides the expected gain across its specified frequency range. Gain flatness is equally important to maintain consistent amplification across different frequencies. Any deviations in gain or gain flatness can lead to signal distortion and effect overall system performance
b. **Output Power:** Measure the maximum output power the amplifier can deliver without distortion. This is usually specified as the saturated output power.
c. **Efficiency:** Measure the power efficiency of the amplifier by comparing the output power to the input power. Efficient amplifiers convert a higher percentage of input power into useful output power.
d. **Operating Frequency:** Analyze the amplifier's response across its specified frequency range to ensure it meets the desired specifications.

3. Are LTE cellular systems using TDD or FDD techniques?

LTE is a high-speed fourth generation 4G communication standard. It's widely used all over the world in cellular communications.

Both FDD(*Frequency Division Duplex*) and TDD(*Time Division Duplex*) are used in LTE. Together they allow fast transfer of multimedia services like voice and data between devices. Your phone or tablet uses this technology to connect to the internet and make voice calls.

4. We have to validate a cellular base station, describe the key parameters on GSM, LTE and UMTS to measure in a lab environment in order to assure that the quality of our BTS is good.

Validating a cellular base station involves testing a wide range of parameters to ensure that the base station's performance meets quality standards. Here are key parameters to measure in a lab environment for GSM, LTE, and UMTS (3G) cellular technologies:

GSM (2G) Parameters:

a. **Coverage and Range**: Measure the base station's coverage area and signal strength at different distances to ensure adequate coverage.

b. **Call Setup and Handover**: Test call setup times, handover performance between cells, and cell reselection to ensure seamless connectivity during mobility.

c. **Call Quality**: Measure voice call quality metrics like Signal-to-Noise Ratio (SNR), Mean Opinion Score (MOS), and audio distortion.

d. **Interference and Adjacent Channel Rejection**: Test the base station's ability to reject interference from adjacent channels and co-channel interference.

e. **Frequency Stability and Accuracy**: Measure the base station's frequency stability and accuracy to ensure it operates within regulatory limits.

LTE (4G) Parameters:

a. **Throughput and Data Rates**: Measure the downlink and uplink data rates to ensure the base station delivers expected throughput under various load conditions.

b. **Modulation and Coding Schemes (MCS)**: Verify that the base station correctly applies different MCS levels based on signal conditions.

c. **Handover and Mobility**: Test handover performance between LTE cells and interoperability with legacy technologies during mobility.

d. **Spectral Efficiency**: Measure the efficiency of spectrum utilization and validate that the base station maximizes data capacity.

e. **MIMO Performance**: Test Multiple-Input Multiple-Output (MIMO) performance for spatial multiplexing and diversity gains.

UMTS (3G) Parameters:

a. **Data Rates**: Measure downlink and uplink data rates to ensure the base station provides adequate capacity.

b. **Handover and Soft Handover**: Validate handover performance between UMTS cells and soft handover operation in areas with overlapping coverage.

c. **Quality of Service (QoS)**: Test QoS parameters like packet loss, jitter, and delay for data and voice services.

d. **Cell Reselection**: Evaluate the base station's cell reselection behavior and inter-RAT (Inter Radio Access Technology) handover.

e. **Node B Power Control**: Verify that the base station maintains proper power levels for communication quality and efficient spectrum utilization.

Common Parameters for All Technologies:

a. **Network Registration and Attach/Detach:** Test network registration and attach/detach procedures for user devices.

b. **Idle Mode Behavior:** Measure power consumption and behavior when user devices are in idle mode.

c. **Load Testing:** Assess the base station's performance under heavy load conditions, including data and voice traffic.

d. **Interference Handling:** Evaluate the base station's ability to handle external interference and coexistence with other networks.

e. **Security and Encryption:** Ensure that encryption and security mechanisms are working effectively to protect user data.

f. **Management Interfaces:** Test management interfaces for remote monitoring, configuration, and troubleshooting.

These parameters are just a starting point. The specific test cases and procedures can vary based on regulatory requirements, network design, and the intended deployment scenario. It's essential to work closely with the cellular equipment manufacturer and follow industry best practices to thoroughly validate the quality of your cellular base station.

5. Given 2 tones at the frequencies f1= 1.525 GHz and f2 = 1.575 GHz that are combined to the input of a Power amplifier. At what frequencies we will find:

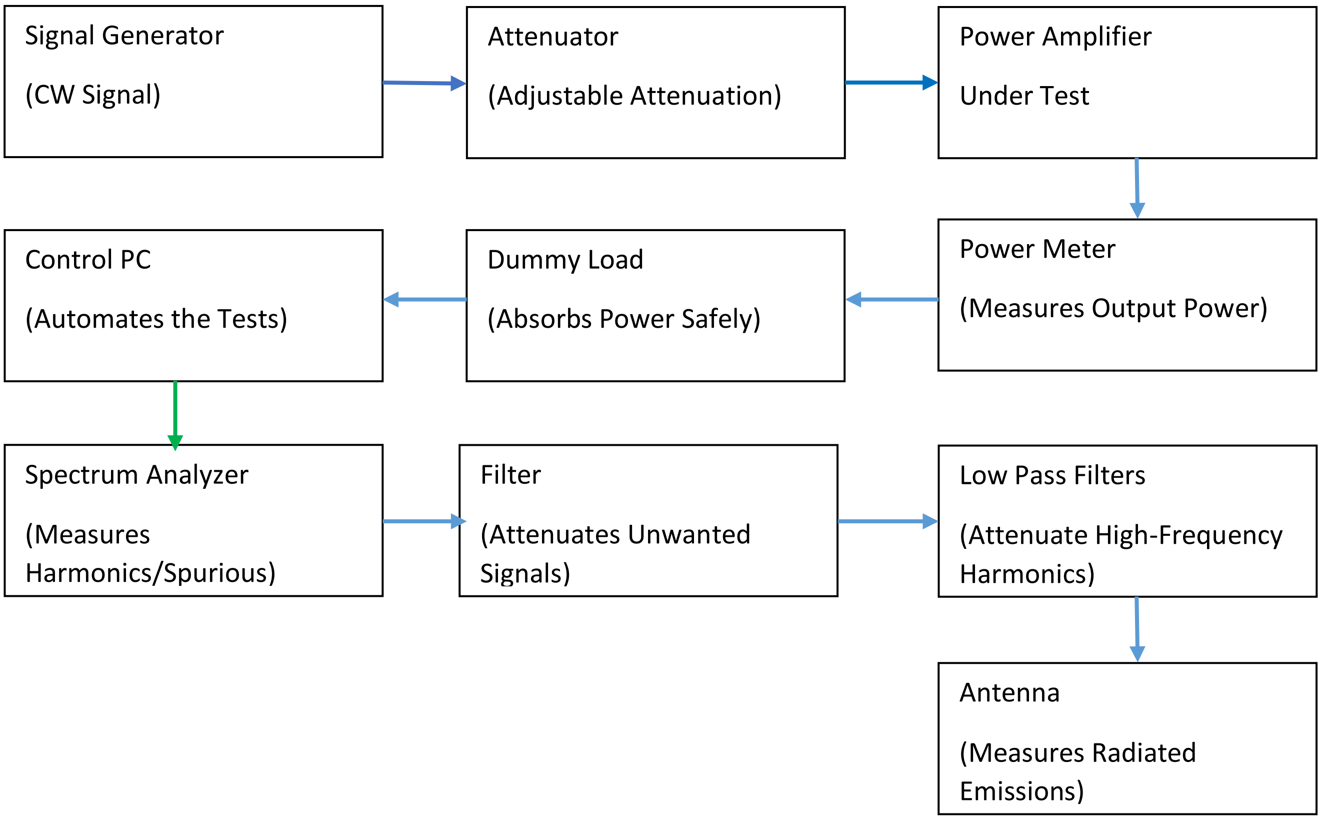
a. 2nd harmonics of the output signals (2 x f1 = 3.05 GHz, 2 x f1 = 3.15GHz)

b. 3rd order intermodulation Products of the output signals (|2 x f1 – f2| ~ 1.47GHz, |2 x f2 – f1|=1.652 GHz)

6. We want to test a 200W power amplifier. Draw the block diagram of the test setup you would use to perform Power test CW and spurious/harmonics test with a single automated setup. Put all protective components to ensure that all lab equipment is safe.

Each block represents a component or a set of components. The setup includes the signal generator, power amplifier under test, power meter, dummy load, control PC, spectrum analyzer, filters, low pass filters, and antenna.

The components are interconnected using RF cables (low loss) for the blue arrows and a USB or ethernet connection for the green arrow. The protective components are depicted conceptually to ensure safety. Actual connections and safety precautions should be established according to the specific needs of your testing environment and equipment.



7. Given a new PCB board with multiple RF inputs and outputs. How would you check the quality of the RF paths of the Board? For example, 3 inputs and 6 outputs. Describe or draw the equipment you would use for that in order to perform the test fully automated.

By combining a Vector Network Analyzer, an RF switch matrix, a calibration kit, and an RF power meter, you can fully automate the testing process for RF paths on a PCB board. This setup allows you to efficiently and accurately test the quality and performance of multiple RF inputs and outputs.

8. How we can know that a power amplifier is being saturated and what are the consequences on the output signals?

A power amplifier is considered to be saturated when it's being driven with an input signal that is too strong, causing the amplifier's output to reach its maximum power limit. Saturated amplifiers exhibit distinctive characteristics that can be identified through various measurements and observations. Here's how you can recognize amplifier saturation and the consequences it has on the output signals:

Indications of Amplifier Saturation:

a. **Flattened Output**: When a power amplifier is saturated, the output signal becomes flattened or "clipped." This means that the peak amplitudes of the output signal are limited to the maximum output power level, resulting in a squared-off waveform.

b. **No Additional Gain**: In a saturated state, the amplifier cannot provide additional gain even if the input signal power is increased. The output power remains constant at its maximum level.

c. **Output Distortion**: Saturation leads to signal distortion, resulting in harmonics and intermodulation products. The distorted signal can be observed on an oscilloscope as irregularities in the waveform.

d. **Compression Point**: The point at which the amplifier starts to saturate is referred to as the "1 dB compression point" or "P1dB." It's the input power level at which the output power is 1 dB below its linear gain.

9. For antennas physically larger than a half-wavelength of the frequency of radiation what is the relation generally used for determine the Far field region?

When dealing with antennas that are physically larger than half-wavelength ($\lambda/2$) of the frequency of radiation, the concept of the "Far Field" region becomes significant. In the Far Field region (also known as the Fraunhofer region), the electromagnetic field properties of the antenna radiation become predominantly dependent on the angle of observation and distance from the antenna rather than the antenna's physical characteristics.

The relationship used to determine the approximate starting point of the Far Field region is known as the "Rayleigh Distance" (*D*), which is defined as:

$D \approx 2D^2/\lambda$

Where:

- *D* is the largest dimension of the antenna (its diameter, length, or width).
- λ is the wavelength of the radiation.

In this context, *D* represents the characteristic size of the antenna, and λ is the wavelength of the radiation being emitted by the antenna. When *D* is larger than $\lambda/2$, the antenna is considered electrically large.

The Rayleigh Distance (*D*) provides an approximation of the distance from the antenna beyond which the Far Field region begins. In the Far Field region, the radiation pattern of the antenna becomes relatively independent of distance, and it takes on a well-defined shape determined by the antenna's geometry and properties.

Keep in mind that the Rayleigh Distance provides an estimation, and the exact transition between the Near Field and Far Field regions can depend on factors such as the antenna type, shape, and operating frequency.

When working with electrically large antennas, understanding the concept of the Far Field region and using the Rayleigh Distance can help in selecting appropriate distances for testing, measurements, and practical applications.

10. We measure a spurious with an antenna at 1 meter from DUT, what solution you can propose for fast check if it’s a real spurious emission?

Performing a quick check to determine if a measured spurious emission is a real issue or an artifact can help save time and resources. Here's a solution that you can consider for a fast check of whether a spurious emission is real:

Use Multiple Antennas for Comparison

1. **Primary Antenna Placement (Test Antenna)**: Place the primary measurement antenna at the standard 1-meter distance from the Device Under Test (DUT). This is the antenna you will use for the actual measurement.

2. **Reference Antenna Placement (Comparison Antenna)**: Place a second antenna, known as the reference antenna, at the same 1-meter distance from the DUT. However, instead of positioning it to receive the emissions directly from the DUT, orient it in a way that minimizes direct signal pickup from the DUT.

3. **Switching Between Antennas**: Use a manually or automatically controlled RF switch to alternate between the primary measurement antenna and the reference antenna without changing the DUT setup.

4. **Comparative Measurement**: Perform the same spurious emission measurement using both the primary and reference antennas. This involves measuring the emissions in the same frequency range for the same duration using both antennas.

If the spurious emissions are real and present, you would expect to see them consistently in both measurements using the primary and reference antennas. The emissions should be present in the same frequency range and with similar characteristics.