MAPCON 2024 Student Design Contest Problems

1. 4 × 4 Circularly Polarized Microstrip Patch Antenna Array
   a. Center Frequency: 8.25GHz
   b. Bandwidth (around center frequency)> 600 MHz
   c. Axial Ratio < 3dBi throughout the band
   d. Gain: > =12 dBi throughout the band
   e. Return loss: >10 dB throughout the band
   f. Polarization: RHCP
   g. Judgment criteria: achieved Bandwidth, VSWR, gain, beamwidth, sidelobes

2. Design of a multi-band LNA integrated antenna for GNSS systems using COTS or designed LNA (GPS/GLONASS/NAVIC/Waidu)
   a) Frequency range: to cover the GPS, GLONASS, NAVIC(IRNSS), Waidu bands
   b) Integrated gain: >20dB
   c) Noise Figure: <2dB
   d) Output 1dB Gain compression point: better than 10dBm
   e) VSWR: better than 2:1
   f) Power handling >20dBm
   g) Judgment criteria: band coverage, gain flatness, noise figure, power handling

3. Design of filter integrated antenna for L/S/C/X band radars
   a. Frequency ranges: 1.2-1.4 GHz, 2.7-3.1 GHz, 5.5-6 GHz, 9-10 GHz (Any one)
   b. Rejection: better than 20dBc 20% away from band edges
   c. Integrated gain: better than 3dB
   d. Judgment criteria: integrated gain, rejection

4. Design of a continuously or discretely tunable bandpass filter for 2-6 GHz band
   a. Freq range: 2-6 GHz
   b. Instantaneous bandwidth: fc+/-10%
   c. Insertion loss <3dB
   d. Rejection at +/-1 GHz: better than 20dB
   e. Rejection at +/-2 Ghz: better than 30dB
   f. VSWR: better than 2:1
   g. Judgment criteria: widest instantaneous bandwidth, lowest insertion loss and best rejection at Fc+/-1 GHz, Fc+/-2 GHz

5. Design of a direction finding FMCW transceiver at 5/10/24 GHz using COTS transceiver IC and designed antenna array
    a. Frequency band: Any of 5/10/24 GHz (as per availability of COTS FMCW transceiver IC)
    b. Detection Range: 300 Meters
    c. Direction finding range: ±30deg
    d. Judgment criteria: Detection range, scan direction range

6. Design of a beam scanning antenna array for sub 6GHz applications
    a. Design of antenna array
    b. Design of beam scanning mechanism
        i. Switching
        ii. Butler matrix
        iii. Rotman lens
        iv. Active scanning

7. Design of a broadband bias tee
    a. Frequency Range: 100 MHz to 15 GHz
    b. Insertion loss in the RF path: Better than 0.8 dB
    c. VSWR: Less than 1.5:1.
    d. DC-RF path Isolation: of minimum 30 dB between 100 MHz and 3 GHz and minimum 20 dB above 3 GHz.
    e. Judgment criteria: Actual bandwidth achieved, losses and isolation values.

8. The World Health Organization (WHO) in 2016 came up with the first global report on diabetes that provided significant leads towards understanding diabetes. The report calls for stronger responses from the society to best utilize science for developing affordable medical technologies for effectively addressing diabetes. In recent years, it has been reported by many research groups that the microwave technology can be effectively utilized to devise an alternate cost-effective methodology for estimation of glucose in blood leading to regular screening and early diagnosis of diabetes.

    Since blood glucose measurement requires sample blood specimens, the amount of blood to be tested/drawn becomes a critical factor when RF testing of such measurements is carried out. The device reusability is another factor that must be deliberated while designing RF sensor systems for glucose detection in blood. When the test sample comes in direct contact with the sensing region, even after flushing out, the sample leaves an imprint on the sensor that may alter further

measurements using the device. This factor should also be properly addressed during the design scheme.

The developed resonant sensor using the planar technology for blood glucose estimation would primarily be judged on following major criteria:

a. Relative sensitivity ($\Delta f / [f_0 \Delta \varepsilon_r] \times 100\%$): ≥ 7-8 %
b. Sensitivity of glucose detection (MHz/*mgdl*$^{-1}$):
c. Quality factor: ≥ 10
d. Size (electrical dimensions): compact size!!
e. Minimum level of glucose estimation (*mg/dl*):
f. Structure novelty;
g. Minimum amount of blood required for testing (*ml/µl*):
h. Reusability of the sensor prototype.