COURSE CODE: 13M1WEC432   MAX. MARKS: 35

COURSE NAME: Radar and Sonar Signal Processing

COURSE CREDITS: 3   MAX. TIME: 2HRS

Note: All questions are compulsory. Carrying of mobile phone during examinations will be treated as case of unfair means. Assume any missing data. Marks are indicated in parenthesis.

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1. Explain the working of a double balanced mixer with 180^0 hybrid. (4m)

2.
   a. Give the scattering parameters of a 6-dB counter clockwise circulator and 6-dB 90^0 hybrid. (2m)

   b. Derive the expression for third order intercept point for a non-linear amplifier. (2m)

3.
   a. An amplifier has a 4dB noise figure (NF). The bandwidth of the amplifier is 500 kHz. Calculate the input signal power that yield a unity SNR at the output. Usually, what might be the reasonable SNR for a receiver? Assume $T_0 = 290K$ and an input impedance of 1ohm. (2m)

   b. A radar receiver consists of an antenna with cable loss 1dB, an RF amplifier with a NF of 6dB and gain of 20dB. This is followed by a mixer whose NF is 10dB and conversion loss of 8dB and then finally an integrated circuit at intermediate frequency (IF) with NF as 6dB and gain of 60dB. Find the overall NF of the receiver. (2m)

4. Draw the working of a 4-way Butler's matrix and how/where do you use this in radar systems. (4m)

5. Explain briefly about the synthetic aperture radar with proper diagrams. (4m)

6. What do mean by pulse compression and explain with the help of Barker codes. (4m)

7. Derive the bi-static radar equation involving different types of losses including all connections. (4m)

8. Explain briefly about the amplitude comparison mono-pulse tracking and early-late gate tracking. (4m)

9. Describe the following briefly.
   a. Sound wave trapping under water in a sea due to velocity gradient. (1m)

   b. Significance of radar cross section. (1m)

   c. Uncertainty in the Doppler velocity. (1m)