

RADIO SCIENCE AND TECHNIQUES FOR SPACE EXPLORATION

Instructor: Prof. Norbert Bartel, PSE 331 bartel@yorku.ca www.yorku.ca/bartel
Course Number: SC/PHYS 4330 3.0 W, LE/ENG 4330 3.0 W
Time/Location: Tuesdays and Thursdays 10:00 am – 11:30 am, HNE 230 when in-person classes resume
Textbooks: *Signals and Systems*, S. Haykin and B. Van Veen, Wiley
Radio Astronomy, J.D. Kraus, Cygnus-Quasar
Radiometric Tracking Techniques for Deep Space Navigation,
C.L. Thornton and J.S. Borders – JPL Pub. 00-11 (Web doc)
Introduction to Radar Analysis – B.R. Mahfza, CRC Press

- Course Contents:
1. Signal Processing Fundamentals
 - 1.1 Continuous and discrete signals
 - 1.2 Fourier series (FS)
 - 1.3 Fourier transform (FT)
 - 1.4 Properties of the FT
 - 1.5 The 2-dim FT
 - 1.6 Linear systems, convolution and filtering
 - 1.7 Energy, power and their spectral densities
 2. Radio Astronomy Fundamentals
 - 2.1 Introduction
 - 2.2 Power, spectral power, brightness and flux density
 - 2.3 Antenna temperature and noise
 - 2.4 Minimum detectable antenna temperature and flux density
 3. Radio Observatory and DSN Instrumentation Fundamentals
 - 3.1 Antennas, antenna arrays and VLBI
 - 3.2 Time and frequency standards
 - 3.3 Multibeam antenna systems
 - 3.4 Receivers
 4. VLBI and DSN Applications to Spacecraft Navigation
(Radiometric tracking techniques for deep-space navigation)
 - 4.1 Introduction
 - 4.2 Earth-based tracking and navigation overview
 - 4.3 Range and Doppler tracking observables
 - 4.4 VLBI tracking observables
 - 4.5 Future directions in radiometric tracking
 5. Introduction to Radar Systems (Radar fundamentals)
 - 5.1 Introduction
 - 5.2 Range
 - 5.3 Doppler frequency or range rate
 - 5.4 The radar equation
 - 5.5 CW radar (FM)

Evaluation: In-class quizzes : 5% of final mark
Homework: 25% of final mark
Midterm exam: 20% of final mark
Summary document: 15% of final mark
Final exam: 35% of final mark

Office hours: P331, Tuesdays 12:30 pm-1:30 pm, send me an email
Midterm exam: March 3, 2022
Final exam: TBA