

ELEC 4600

Radar and Navigation

Course Outline

Week

Section I: Radar Fundamentals

- 1 Radar pulses, range equation. Pulse repetition frequency and unambiguous range, Block diagram: exciter, magnetron, duplexer, antenna, receiver protector, superheterodyne receiver, digital signal processor. Applications: air traffic control, aircraft altimeter, aircraft doppler navigator, ship safety and harbor surveillance, space and remote sensing, tracking.
- 2 Minimal detectable signal, receiver noise, probability density function, SNR, probability of detection, probability of false alarm, integration of radar pulses, integration improvement factor
- 3 Target cross section: sphere, cone sphere corner reflector, cross section fluctuations, Swerling classification,
- 4 Swerling classification effect on S/N and integration improvement factor, multiple pulse repetition frequencies and range ambiguities, cosecant² θ contour for antenna elevation beam, beam shape loss, collapsing loss, waveguide loss

Section II: MTI Surveillance Radar

- 5 Two way Doppler, Moving Target Indicator and Pulse Doppler radars, power oscillator and power amplifier MTI architectures, delay line cancellers, two pulse and three pulse cancellers, multiple and staggered PRFs
- 6 Digital signal processing, range-gated FFT, improved S/N, improved velocity estimation, constant false alarm rate
- 7 Example of an MTI processor, clutter attenuation, sub-clutter visibility, clutter visibility factor,

Section III: Radio Navigation

- 8 Organizations: ICAO, ARINC, RTCA, heading, relative and magnetic bearing, lines of position, NDB (non-directional beacon), ADF (automatic direction finder), VOR (VHF omnirange)
- 9 Doppler VOR, DME (distance measuring equipment), TACAN, ILS (instrument landing system)

Section IV: GPS

- 10 Orbits: inclination angle, longitude of ascending node, argument of perigee, semi-major axis, eccentricity, true anomaly, eccentric anomaly, mean anomaly, ECI (earth centered inertial coordinate system), ECEF (earth centered earth fixed coordinate system)
- 11 Signal format: direct sequence spread spectrum, Fibonacci PN sequence generation, sequence synchronizers, CA code (coarse acquisition code), P code (precision code), clock correction and ephemeris data, almanac data, position calculation, GDOP (geometric dilution of precision)
- 12 Ionosphere errors, local differential GPS, wide area augmentation, GEOIDE, geocentric latitude, geodetic latitude, meridian radius of curvature, prime radius of curvature, conversion between geodetic and ECEF coordinates

Course Grading

Two midterm exams at 20% each	40%
Final exam	60%

Reference Texts

- M. Skolnik, "Introduction to Radar Systems", McGraw Hill
- M. Kayton & W.R. Fried, "Avionics Navigation Systems", Wiley