INTRODUCTION TO RADAR & SATELLITE ENGINEERING

ECE 514E – RADAR & SATELLITE ENGINEERING

Monday, 8 September 2025

ECE 514E SYLLABUS

Pre-requisites:

ECE 328 - Principles of Communication Systems,

ECE 416 - Digital Communication Systems

Course Purpose:

To enable students be familiarize with modern radar and navigation systems and principles of design radio-navigation and location systems, as well as radar systems

WHY IS THIS COURSE IMPORTANT? /1-1

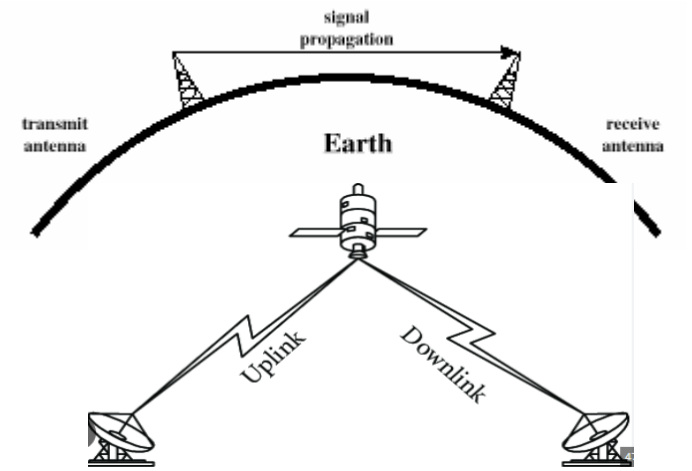
1. Knowledge of **Radar** is essential for engineers who whish to understand wireless ranging, i.e precise determination of distance between two objects and remote sensing.
2. **Principles of radar** are essential for detection of objects in other media such as water (undersea measurements)

WHY IS THIS COURSE IMPORTANT? /1-2

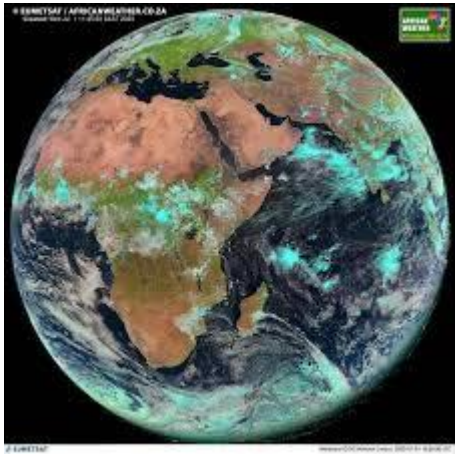
3. **Principles of radar** are essential for one to understand
   a) Avionics (navigation, communication, etc.)
   b) Remote sensing
   c) Medical applications such as ultrasound and NMR

WHY IS THIS COURSE IMPORTANT? /2-1

1. **Satellite systems** allow us to communicate at microwave frequencies over the radio horizon.

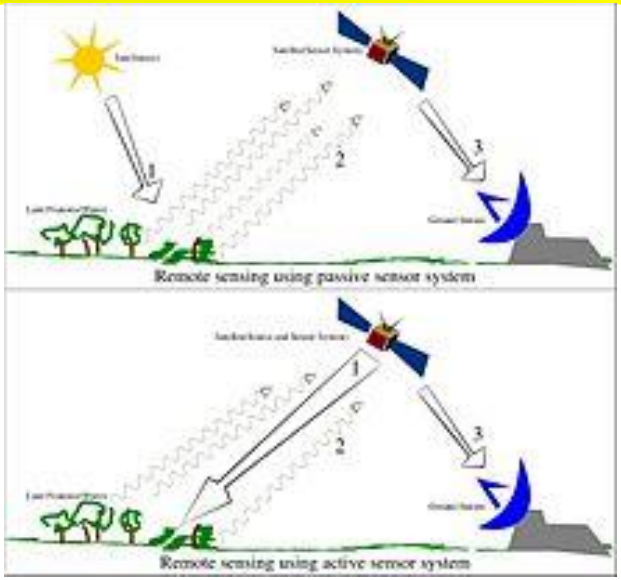


2. **Weather Satellite systems** allow us to monitor and predict weather conditions.



WHY IS THIS COURSE IMPORTANT? /2-2

1. **Satellite systems** support remote sensing applications for surface mounted and underground objects/conditions.



2. **Satellites** are used as recovery systems when fibre communication system fail or are under maintenance.

ECE 514E SYLLABUS (2)

Expected Learning Outcomes:

Upon completion of this course, a student should be able to:

(a) explain principles of operation of radar systems;

(b) apply theoretical and practical knowledge about principles, methods and applications of modern radar systems;

(c) measure and identify the parameters which determine the performance of radar systems;

(d) explain the function of satellite subsystems;

(e) apply orbital mechanics formula and tools to spacecraft mission design;

(f) select appropriate launch systems and understand their effect on satellite and payload design and performance;

(g) design and analyse satellite links;

(h) evaluate satellite subsystem performance

ECE 514E SYLLABUS (3)

Course Content (1)

1. **Basic Principles of Radar:** Antenna parameters, Radar equation. Performance parameters, target cross-section,
2. **MTI and Doppler radar:** Doppler Effect, CW radar, FMCW radar, Delay line cancellers, Pulse Doppler Radar.
3. **Scanning, Duplexers and Radar receivers:** Sequential lobbing, Conical Scanning, Monopulse Tracking RADAR, Tracking with surveillance RADAR, Acquisition, Radar receiver, Radar Displays; Duplexers

ECE 514E SYLLABUS (5)

Course Content (2)

4. **Introduction to satellite communication:** international regulation & frequency coordination, satellite frequency allocation & band spectrum, active & passive satellites.
5. **Orbits and Launching Methods:** Kepler's laws, orbital elements, apogee and perigee heights, orbital perturbations, effects of non-spherical earth, atmospheric drag, the geostationary orbit, antenna look angles, polar mount antenna, limits of visibility, earth eclipse of satellite, sun transit outage, launches and launch vehicles.
6. **Satellite Subsystems:** power supply, altitude control, station keeping, thermal control, transponders, antenna subsystem.

ECE 514E SYLLABUS (6)

Course Content (2)

7. **Earth stations:** transmit/receive earth stations.
8. **Space Segment:** Introduction, equivalent isotropic radiated power, transmission losses, link power budget equation, system noise, carrier-to noise ratio.
9. **Interference:** interference between satellite circuits, combined (C/I) due to interference on uplink and downlink, antenna gain function, pass band interference.

ECE 514E SYLLABUS (7)

Recommended book:

(a) Skolnik M. I, **Introduction to Radar Systems**, McGraw-Hill

(b) Gerard Maral, Michel Bousquet, **Satellite Communications Systems: Systems, Techniques and Technology**, ISBN: 0-471-49654-5.

(c)

(d) Kadish J.E. and East T.W.R., **Satellite Communication Fundamentals**, Artech House Books, ISBN: ISBN-10: 1580531369