

Radar principles (0510-7204) – Fall 2025-2026**Teacher: Dr. Itzik Cohen, TA: Yarden Haskin**

Building: Software Engineering, room 104

Wednesday 15:00-18:00

CONTACT:

- itzikcoh@post.tau.ac.il
- Moodle Q&A forum

OFFICE HOURS:

- Online (zoom): Tuesday 10:00-12:00
- In person: Wednesday 18:00-19:00 (after class)
- Additional office hours by appointment

PREREQUISITES:

- Random Signals and Noise (0512-3632 or equivalent)
- Signals and Systems (0512-2835 or equivalent)

WAY OF TEACHING:

- 13 lectures.
- In person (not hybrid).
- All lectures are recorded and will be available in Panopto the day after.

COURSE REQUIREMENTS AND GRADING:***Final grade = 25% Homework + 75% Final exam/assignment***

- **Homework (25%)**: 6 homework assignments will be given during the semester. Homework grade is calculated as the average of 4 assignments (the lowest two grades will not be included).
- **Final exam/assignment (75%)**: A take-home exam held during the exam period.
- Both homework and the exam will include analytical questions and simulation tasks (MATLAB or Python, student's choice).
- Homework and the final exam/assignment are **individual work**.

Assignment schedule and submission deadlines:

Assignment	Release date	Submission date
HW 1	5/11 (week #2)	19/11 (week #4)
HW 2	19/11 (week #4)	3/12 (week #6)
HW 3	3/12 (week #6)	17/12 (week #8)
HW 4	17/12 (week #8)	31/12 (week #10)
HW 5	31/12 (week #10)	14/1 (week #12)
HW 6	14/1 (week #12)	Not to be submitted
Final assignment	8/2 (week #3 of exam period)	20/2 (end of week #4 of exam period)

2025 – adjustments due to war:

Groups B&C: Submission of homework is not mandatory (though still highly encouraged). Homework score is "Magen" of 25%. ***Final grade = max(25% Homework + 75% Final assignment, 100% Final assignment)***.

COURSE TOPICS:

- **Introduction:** Radar tasks, history, and basic concepts, delay and Doppler, range and Doppler ambiguity, the radar equation, SNR, coherent pulse train, Aperture and array antennas, Propagation in the atmosphere
- **Radar Cross Section (RCS):** RCS of deterministic targets, RCS and coherency of multi-scatterer statistical targets, Swerling models (outline and simulations)
- **Ground effects:** multipath and clutter
- **Matched filter**
- **Ambiguity function (AF),** Periodic AF of a coherent pulse train
- **Doppler processing:** optimal Doppler processing, FFT processing, Moving Target Indicator (MTI) and clutter suppression
- **Detection:** Detection of single pulse, Pd and Pfa, Coherent and non-coherent integration, Binary integration
- **Constant false alarm rate (CFAR):** detection with adaptive threshold, cell averaging CFAR, order statistics CFAR, additional CFAR methods
- **Radar waveforms and pulse compression:** Linear frequency modulation (LFM) and NLFM, Frequency coding (Costas arrays), Binary phase coding, Polyphase coding and Polyphase Barker, Stepped frequency, Complementary pairs, Multicarrier, Mismatched filters
- **Continuous Wave (CW) radar,** LFM-CW, Stretch processing, Phase coded CW
- **MIMO radar:** introduction to angle of arrival estimation (aperture antenna; phased array antenna), the virtual array, multiplexing techniques (TDM / FDM / DDM / CDM) and their tradeoffs, the MIMO ambiguity function
- **Radar Measurements:** SNR dependence of delay, frequency, and direction measurements

RECOMMENDED READING:

This book closely follows the course topics, as was given on the Fall 2020-2021 semester:

- N. Levanon, Radar - Concise Course Vol. 1 & Vol. 2, 2021.

Most of the course topics are covered by these books:

- N. Levanon, Radar Principles, Wiley, 1998.
- N. Levanon, E. Mozeson, Radar Signals, Wiley, 2004.
- M.A. Richards, Fundamentals of Radar Signal Processing, 3rd ed., McGraw-Hill, 2022.

FURTHER READING:

- P.E. Pace, Detecting and Classifying Low Probability of Intercept Radar, 2nd ed., Artech, 2009.
- M. Skolnik, Introduction to Radar Systems, 3rd ed., McGraw-Hill, 2002.
- M.A. Richards, Principles of Modern Radar – Basic Principles, SciTech, 2010.
- W.L. Melvin, Principles of Modern Radar – Advanced Techniques, SciTech, 2012.
- G.W. Stimson, Stimson's Introduction to Airborne Radar, Hughes Aircraft Co., 1983 (2nd ed., SciTech, 1990). Updated 3rd ed., SciTech 2014, H.D. Griffiths, C. J. Baker, D. Adamy
- A.W. Rihaczek, Principles of High-Resolution Radar, McGraw-Hill, 1969 (Artech, 1996)
- B. R. Mahafza, Radar Systems Analysis and Design Using MATLAB, 4th ed., CRC Press, 2022.
- M.C. Budge Jr., S.R. German, Basic Radar Analysis, Artech House, 2015.