

Advanced Technology Education Program

معهد الأمير سلطان
لأبحاث التقنيات المتقدمة

Prince Sultan Advanced
Tech. Research Institute

www.psatri.org.sa



PSATRI

Modern Radar Systems

(ATEP 01) 10 Apr. - 14 Apr. 2016

Training Course Information:

Modern Radar Systems (ATEP 01)

10 Apr. - 14 Apr. 2016

COURSE AIMS

This course aims to impart an appreciation of the capabilities, techniques and applications of modern military radar systems. It provides a basic level of analysis between the operational parameters and the role and capabilities of modern radar systems.

PRE-REQUISITES

This course assumes no prior knowledge of the subject matter, however, it is recommended that students have a background in maths, science or engineering. Students should be competent in high-school level mathematics.

WHO SHOULD ATTEND

- Military technicians,
- Engineering officers,
- Defence personal involved in the procurement or specification of radar systems,
- Radar users and operators,
- Defence industry technicians and graduate engineers,
- Engineering management requiring an appreciation of radar,
- Graduate students in mathematics, science or engineering subjects.

COURSE CONTENT

Fundamental Concepts (1 hr)

- Basic concepts of radar
- Comparison of radar with other sensors
- Primary/secondary radar
- Monostatic, bistatic, multi-static configurations
- Block diagram
- Radar frequency bands
- Atmospheric attenuation
- Relationship between size, power, range and application
- Target parameters measurable by a radar

Radar Antennas (2 hr)

- Antenna parameters
- (matching, reciprocity, bandwidth, beamwidth, gain, effective aperture, radiation diagram, sidelobes, radiation resistance)
- Sidelobe control using tapered illumination functions
- Polarisation
- Microstrip Patch
- Waveguide Horn
- Parabolic Reflector
- Cassegrain Antenna

Radar Antennas (1 hr)

- Linear, planar, conformal arrays
- Array factor
- Electronic beam steering (E-scan arrays)
- Grating Lobes, element spacing requirements

- Advantages of electronic scanning over mechanical scanning
- Beam dilation
- Transmit Receive Modules (TRM), block diagram, digital control of phase & amplitude.

Pulsed Radar Parameters (1 hr)

- The Pulsed Principle
- Duty cycle, peak and average powers
- Pulse delay ranging, range gating
- Minimum range
- Maximum unambiguous range, low PRF
- Spectrum of pulsed radar
- Matched reception
- Range resolution
- Range accuracy
- Straddling Losses, multiple range sampling

Pulse Compression (1 hr)

- Factors influencing the duration of the transmitted pulse width, detection performance (range) vs. range resolution.
- The pulse compression concept.
- Linear frequency modulation.
- Compression factor.
- Range resolution as a function of bandwidth
- Matched filtering
- Range side lobes
- LFM spectrum
- Stepped frequency CW, resolution and unambiguous range
- Phase coding using Barker codes and other coding strategies.

- Range Doppler coupling
- Effects of eclipsing.

Radar Detection in Noise (2 hr)

- Radar range equation
- Threshold detection
- Probability of detection (Pd)
- Probability of false alarms (Pfa), false alarm rate (FAR), (noise-) bandwidth
- The nature of noise
- Sources of noise
- Thermal noise, statistics
- Noise Figure/Temperature
- Signal to noise ratio (SNR)
- Benefits of pulse integration
- System Losses
- Beam shape Losses
- Propagation losses,
- Atmospheric Losses, clear-air, poor weather
- Radar Cross Section Definition
- RCS of simple shapes
- Factors Influencing RCS
- Typical mean RCS of real targets
- Scintillation, allowance of extra SNR

Radar Range Equation - tutorial / worked example (1 hr)

- A worked example with be conducted within a tutorial session.

Clutter (1 hr)

- Surface clutter
- Volume clutter
- Backscatter coefficients
- Sources of clutter
- Land clutter
- Sea clutter
- Clutter limited detection ranges
- Statistical model of clutter (simplified models presented)
- Temporal decorrelation of clutter
- Anti-clutter techniques

Constant False Alarm Rate (CFAR) Detection (1hr)

- Adaptive thresholding
- Range cell averaging CFAR
- Assumptions and problems of cell averaging CFAR

CW Doppler Sensing & Frequency Modulation (FM) Ranging (1 hr)

- CW radar block diagram
- The Doppler effect
- Problems of CW Systems & Applications
- Baseband signals
- Linear Frequency Modulation (LFM) ranging
- 2 phase LFM (with/without Doppler)
- Sine FM Ranging

Doppler Processing (1 hr)

- Doppler effect in pulsed radars
- Quadrature detection

- Discrete Fourier Transform (DFT) (conceptual description)
- Velocity gating
- The Coherent Processing Interval (CPI)
- Velocity resolution
- Clutter rejection
- Processing gains and losses

CW Doppler Radar – demonstration (1 hr)

- The I/Q channel waveforms from a quadrature detector, Doppler signature of targets and DFT processing will be demonstrated with a live radar in the classroom.

Moving Target Indicator (MTI) and Low PRF Pulse Doppler Radar (1hr)

- Combining pulsed (ranging) with Doppler (velocity) systems
- Range and Velocity Ambiguities
- Problems of low PRF pulse Doppler
- Low PRF Pulse Doppler Applications
- Baseband Doppler
- MTI cancellers
- Blind zones, Staggered/multiple PRFs
- Digital MTI cancellation
- MTI cancellation parameters

High PRF Pulse Doppler Radar (1 hrs)

- High PRF Pulse Doppler Radar
- Unambiguous velocity
- Range ambiguity
- Typical waveform parameters
- Velocity search modes
- HPRF response to clutter

- Eclipsing
- Multiple PRF operation, avoidance of eclipsing, resolving range ambiguity
- FMICW
- Applications

Medium PRF Pulse Doppler Radar (1 hr)

- Range and velocity ambiguities
- Multiple PRF schedules
- Factors effecting choice of PRF
- Decoding range/velocity
- Blindness
- Maximum, minimum & mean PRF limits
- Typical parameters
- Applications

Tracking Radar (2 hrs)

- Range Tracking
- Velocity Tracking
- Monopulse Angle Tracking
- Tracking Errors due to Noise
- Tracking Errors due to Glint
- Low angle tracking, multi-pathing errors
- Frequency Agility
- Track-While-Scan, concepts

Tracking Radar – demonstration (1 hr)

- A live demonstration of amplitude comparison monopulse angle discrimination

Biographies

Sami M. Alhumaidi, Ph.D.

Dr. Sami Alhumaidi is currently the Managing Director of Prince Sultan Advanced Research Institute (PSATRI), an applied research institute at King Saud University (Riyadh, Saudi Arabia) established by the Ministry of Defense and jointly managed by KSU and the Royal Saudi Air Force. Dr. Alhumaidi has obtained his Ph.D. Degree in Electrical Engineering from Florida Institute of Technology in 1996 and his MSEE from the California State University, Northridge, CA, in 1993. He has numerous publications in the areas of radar and electronic warfare and serves on a number of national committees on electronic defense and unmanned aerial vehicles.



Clive M. Alabaster, Ph.D.

Dr. Clive M. Alabaster received his BSc degree in Physics with Microelectronics from University College Swansea, Wales, in 1985 and his PhD Cranfield University, Shrivensham in 2004. From 1985 to 1992 he worked as a microwave design and development engineer on airborne radar systems with GEC Marconi, Milton Keynes, England. From 1992 to 1998 he worked as a lecturer in radar techniques at Arborfield Garrison, near Reading, England. From 1998 to 2012 he was a Senior Lecturer at Cranfield University, Shrivensham, UK in the Sensors group within the Department of Informatics and Sensors. His research interests include pulse Doppler radar, radar waveform design and the dielectric properties of materials, particularly in the millimetre wave band. He is a member of the Institute of Physics and is a Chartered Engineer.



Evan J. Hughes, Ph.D.

Dr. Evan J. Hughes received his BEng and MEng degrees in Electrical and Electronic Engineering from the University of Bradford, England, in 1993 and 1994 respectively. He received his Ph.D. in 1998 from Cranfield University, Shrivensham. From 1993 to 1995 he worked as a design engineer with GEC Marconi, Leicester. From 1998 to 2012 he was a Senior Lecturer at Cranfield University, Shrivensham, UK in the Sensors group within the Department of Informatics and Sensors. His primary research interests include Radar signal processing, Evolutionary Many-Objective Optimisation, swarm guidance and data fusion. He is a member of the IET, is a Chartered Engineer and chaired the IET Radar, Sonar and Navigation Professional Network from 2006 to 2010 and was the Technical co-chair for RADAR 2012 in Glasgow.



Modern Radar Systems Course Pre-registration Form

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Name :

Rank / Job title :

Tel. : Mobile :

Employer Name :

Employer Address :

E-Mail Address :

Employer Tel. : Fax :

Course Name: **Modern Radar Systems**

Course Dates: **10 Apr. - 14 Apr. 2016**

Course Reference: **ATEP 01**

Course Fees: **SAR 11,500**

I hereby certify that I would like to pre-register for the above course. I understand that to confirm my registration, I must complete the payment by 03 Apr 2016 otherwise my registration may be cancelled.

Name :

Signature : Date :

Method of Payment

Account No.: 2680741005

Beneficiary Name:

Prince Sultan Advanced Technology Research Institute

Bank Name: Samba

Swift Code: SAMBSARI

IBAN Number : SA5940000000002680741005

Pre-registration:

Send a completed Pre-registration form via email or Fax prior to **03 Apr 2016** to:

atep.training@psatri.org.sa, Fax: +966 11 2742841

For further information, please visit or send email:

www.psatri.org.sa

atep.training@psatri.org.sa

*King Saud University
P.O.Box: 800 Riyadh 11421
Kingdom of Saudi Arabia
Tel : +966 11 4695130
Fax : +966 11 4673350*

*Business Gate Branch,
Bldg. C-34, 2247
Airport Rd, Qurtubah,
Riyadh 13244-7730
Kingdom of Saudi Arabia
Tel : +966 11 2741323
Fax : +966 11 2742841*

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