2011 Defense Security + Sensing

SPIE Courses

Conference and Course Dates: 25–29 April 2011
Orlando World Center Marriott
Resort & Convention Center
Orlando, Florida, USA
spie.org/dsscourses
Money-back Guarantee

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SPIE reserves the right to cancel a course due to insufficient advance registration.

Conference Dates: 25–29 April 2011
Exhibition Dates: 26–28 April 2011
Orlando World Center Marriott Resort & Convention Center
Orlando, Florida, USA

This program is current as of 24 January 2011. For latest updates: spie.org/dsscourses

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Register for a course:
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- Further your career through ongoing education
- Earn CEUs for your continuing education

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Register today:
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Continuing Education Units
SPIE has been approved as an authorized provider of CEUs by IACET, The International Association for Continuing Education and Training (Provider #1002091). In obtaining this approval, SPIE has demonstrated that it complies with the ANSI/IACET Standards which are widely recognized as standards of good practice.
**New and Expanded Courses for 2011:**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor(s)</th>
<th>Days</th>
<th>Times</th>
<th>Registration Fee</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>SC1031</td>
<td>Radar Micro-Doppler Signatures - Principles and Applications</td>
<td>Chen / Tamoush</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $530 / $620</td>
<td>11</td>
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<tr>
<td>SC1032</td>
<td>Direct Detection Laser Radar Systems</td>
<td>Richmond / Cain</td>
<td>Mon</td>
<td>8:30 am to 12:30 pm, $385 / $435</td>
<td>10</td>
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<tr>
<td>SC1033</td>
<td>Optical Phased Array Technologies and Systems</td>
<td>Probst / McManamon</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $1035 / $1255</td>
<td>12</td>
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<tr>
<td>SC1034</td>
<td>Lab-on-a-Chip Technology—Towards Portable Detection Systems</td>
<td>Gärtner</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $520 / $610</td>
<td>13</td>
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<tr>
<td>SC1035</td>
<td>Military Laser Safety</td>
<td>Marshall</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>15</td>
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<tr>
<td>SC1036</td>
<td>Diode Pumped Alkali Lasers</td>
<td>Perram</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
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<tr>
<td>SC1037</td>
<td>Infrared Optics and Zoom Lenses</td>
<td>Mann</td>
<td>Mon</td>
<td>8:30 am to 12:30 pm, $320 / $370</td>
<td>11</td>
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<tr>
<td>SC944</td>
<td>Cost-Conscious Tolerancing of Optical and IR Systems</td>
<td>Youngworth / Contreras</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $350 / $400</td>
<td>14</td>
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<tr>
<td>SC947</td>
<td>The Radiometry Case Files</td>
<td>Grant</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $350 / $400</td>
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<tr>
<td>SC950</td>
<td>Infrared Imaging Radiometry</td>
<td>Richards</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $350 / $400</td>
<td>13</td>
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<tr>
<td>SC954</td>
<td>Infrared Window and Dome Materials</td>
<td>Harris</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>10</td>
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<tr>
<td>SC955</td>
<td>Understanding Reflective Optical Design</td>
<td>Contreras</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>13</td>
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<tr>
<td>SC967</td>
<td>Testing and Evaluation of E-O Imaging Systems</td>
<td>(Volmerhausen)</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
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<tr>
<td>SC659</td>
<td>Understanding Reflective Optical Design</td>
<td>Contreras</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
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<tr>
<td>SC789</td>
<td>Introduction to Optical and Infrared Sensor Systems</td>
<td>Shaw</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
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</tbody>
</table>

**IR Sensors and Systems**

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Instructor(s)</th>
<th>Days</th>
<th>Times</th>
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<tbody>
<tr>
<td>SC713</td>
<td>Engineering Approach to Imaging System Design</td>
<td>Holst</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $530 / $620</td>
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<tr>
<td>SC278</td>
<td>Infrared Detectors</td>
<td>Dereniak</td>
<td>Mon</td>
<td>8:30 am to 12:30 pm, $385 / $435</td>
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<tr>
<td>SC835</td>
<td>Infrared Systems - Technology &amp; Design</td>
<td>Daniels</td>
<td>Tues</td>
<td>8:30 am to 5:30 pm, $1035 / $1255</td>
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<tr>
<td>SC178</td>
<td>Introduction to Radiometry and Photometry</td>
<td>Grant</td>
<td>Mon</td>
<td>8:30 am to 12:30 pm, $390 / $440</td>
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<tr>
<td>SC900</td>
<td>Uncooled Thermal Imaging Detectors and Systems</td>
<td>Hanson</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $520 / $610</td>
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<td>SC152</td>
<td>Infrared Focal Plane Arrays</td>
<td>Dereniak, Hubbs</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
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<tr>
<td>SC1000</td>
<td>Introduction to Infrared and Ultraviolet Imaging Technology</td>
<td>Richards</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $350 / $400</td>
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<tr>
<td>SC944</td>
<td>The Radiometry Case Files</td>
<td>Grant</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $350 / $400</td>
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<td>SC950</td>
<td>Infrared Imaging Radiometry</td>
<td>Richards</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $350 / $400</td>
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<td>Richards</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
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<tr>
<td>SC838</td>
<td>Laser Range Gated Imaging Techniques</td>
<td>Duncan</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
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<tr>
<td>SC1035</td>
<td>Military Laser Safety</td>
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<td>SC947</td>
<td>Cost-Conscious Tolerancing of Optical and IR Systems</td>
<td>Youngworth / Contreras</td>
<td>Weds</td>
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<tr>
<td>SC755</td>
<td>Infrared Optics and Zoom Lenses</td>
<td>Mann</td>
<td>Thurs</td>
<td>8:30 am to 12:30 pm, $320 / $370</td>
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<td>SC789</td>
<td>Introduction to Optical and Infrared Sensor Systems</td>
<td>Shaw</td>
<td>Fri</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>12</td>
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</table>

**Additional Notes:**

- New courses are indicated with a NEW tag.
- Course fees are subject to change and are based on the type of registration (early bird, standard).
- Contact SPIE Events for more details and registration.

Get the training you need to stay competitive in today's job market:

Courses at SPIE Events offer an engaging experience for those who prefer face-to-face instruction, where interaction with the instructor and sharing information with other students provide increased value to your career development.

Make the most of your time at SPIE Defense, Security, and Sensing—get training and access to professional development courses that will help you meet changing job demands and improve your job performance.
## Defense, Homeland Security, and Law Enforcement

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Day</th>
<th>Time</th>
<th>Description</th>
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<tbody>
<tr>
<td>SC719</td>
<td>Mon</td>
<td>8:30 am to 12:30 pm, $275 / $325</td>
<td>Chemical &amp; Biological Detection: Overview of Point and Standoff Sensing Technologies (Gardner)</td>
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<tr>
<td>SC954</td>
<td>Mon</td>
<td>8:30 am to 12:30 pm, $480 / $570</td>
<td>Scanning Microscopy in Forensic Science (Platek, Trimp, Mcl/ver, Postle)</td>
</tr>
<tr>
<td>SC1035</td>
<td>Weds</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Military Laser Safety (Marshall)</td>
</tr>
<tr>
<td>SC995</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Target Detection Algorithms for Hyperspectral Imagery (Nasrabadi)</td>
</tr>
<tr>
<td>SC1034</td>
<td>Fri</td>
<td>8:30 am to 12:30 pm, $275 / $325</td>
<td>Lab-on-a-Chip Technology - Towards Portable Detection Systems (Gartner)</td>
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## Imaging and Sensing

<table>
<thead>
<tr>
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<td>SC1000</td>
<td>Mon</td>
<td>1:30 to 5:30 pm, $310 / $360</td>
<td>Introduction to Infrared and Ultraviolet Imaging Technology (Richards)</td>
</tr>
<tr>
<td>SC1031</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>Radar Micro-Doppler Signatures - Principles and Applications (Chen, Tathamoush)</td>
</tr>
<tr>
<td>SC944</td>
<td>Mon</td>
<td>1:30 to 5:30 pm, $350 / $400</td>
<td>The Radiometry Case Files (Grant)</td>
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<tr>
<td>SC950</td>
<td>Tues</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Infrared Imaging Radiometry (Richards)</td>
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<tr>
<td>SC838</td>
<td>Tues</td>
<td>1:30 to 5:30 pm, $275 / $325</td>
<td>Laser Range Gated Imaging Techniques (Duncan)</td>
</tr>
<tr>
<td>SC946</td>
<td>Tues</td>
<td>8:30 to 5:30 pm, $480 / $570</td>
<td>Super Resolution in Imaging Systems (Bagheri, Javid)</td>
</tr>
<tr>
<td>SC157</td>
<td>Weds</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>MTF in Optical and Electro-Optical Systems (Ducharme)</td>
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<tr>
<td>SC194</td>
<td>Weds</td>
<td>8:30 am to 12:30 pm, $275 / $325</td>
<td>Multispectral and Hyperspectral Image Sensors (Lomheim)</td>
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<tr>
<td>SC947</td>
<td>Weds</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Cost-Conscious Tolerancing of Optical and IR Systems (Youngworth, Contreras)</td>
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<tr>
<td>SC952</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Applications of Detection Theory (Carrano)</td>
</tr>
<tr>
<td>SC1033</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Optical Phased Array Technologies and Systems (Probst, McManamon)</td>
</tr>
<tr>
<td>SC995</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Target Detection Algorithms for Hyperspectral Imagery (Nasrabadi)</td>
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## Laser Sensors and Systems

<table>
<thead>
<tr>
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<th>Day</th>
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<th>Description</th>
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<tbody>
<tr>
<td>SC167</td>
<td>Mon</td>
<td>8:30 am to 12:30 pm, $275 / $325</td>
<td>Introduction to Laser Radar (Kamerman)</td>
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<tr>
<td>SC168</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Advanced Coherent Laser Radars Design and Applications (Kamerman)</td>
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<tr>
<td>SC1031</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>Radar Micro-Doppler Signatures - Principles and Applications (Chen, Tathamoush)</td>
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<tr>
<td>SC1032</td>
<td>Tues</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>Direct Detection Laser Radar Systems for Imaging Applications (Richmond, Cain)</td>
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<tr>
<td>SC160</td>
<td>Tues</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Precision Stabilized Pointing and Tracking Systems (Hilbert)</td>
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<td>SC838</td>
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<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>Laser Range Gated Imaging Techniques (Duncan)</td>
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<tr>
<td>SC1035</td>
<td>Weds</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Military Laser Safety (Marshall)</td>
</tr>
<tr>
<td>SC1036</td>
<td>Weds</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>Diode Pumped Alkali Lasers (Perram)</td>
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<tr>
<td>SC997</td>
<td>Tues</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>High Power Laser Beam Quality (Ross)</td>
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<td>SC947</td>
<td>Weds</td>
<td>8:30 am to 5:30 pm, $550 / $640</td>
<td>Cost-Conscious Tolerancing of Optical and IR Systems (Youngworth, Contreras)</td>
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<tr>
<td>SC188</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Laser Beam Propagation for Applications in Laser Communications, Laser Radar, and Active Imaging (Phillips, Andrews)</td>
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<td>SC1033</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Optical Phased Array Technologies and Systems (Probst, McManamon)</td>
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<tr>
<td>SC995</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Target Detection Algorithms for Hyperspectral Imagery (Nasrabadi)</td>
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## Sensor Data and Information Exploitation

<table>
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<tr>
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<tr>
<td>SC1031</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $520 / $610</td>
<td>Radar Micro-Doppler Signatures - Principles and Applications (Chen, Tathamoush)</td>
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<tr>
<td>SC994</td>
<td>Tues</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>Multisensor Data Fusion for Object Detection, Classification and Identification (Klein)</td>
</tr>
<tr>
<td>SC181</td>
<td>Tues</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>Predicting Target Acquisition Performance of Electro-Optical Imagers (Vollmerhausen)</td>
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<tr>
<td>SC1035</td>
<td>Weds</td>
<td>8:30 am to 5:30 pm, $275 / $325</td>
<td>Military Laser Safety (Marshall)</td>
</tr>
<tr>
<td>SC194</td>
<td>Weds</td>
<td>8:30 am to 12:30 pm, $275 / $325</td>
<td>Multispectral and Hyperspectral Image Sensors (Lomheim)</td>
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<tr>
<td>SC158</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Fundamentals of Automatic Target Recognition (Sadjadi)</td>
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<tr>
<td>SC995</td>
<td>Thurs</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Target Detection Algorithms for Hyperspectral Imagery (Nasrabadi)</td>
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## Signal, Image, and Neural Net Processing

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<th>Day</th>
<th>Time</th>
<th>Description</th>
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<td>SC066</td>
<td>Mon</td>
<td>8:30 am to 5:30 pm, $550 / $640</td>
<td>Fundamentals of Electronic Image Processing (Weeks)</td>
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<tr>
<td>SC994</td>
<td>Tues</td>
<td>8:30 am to 5:30 pm, $480 / $570</td>
<td>Multisensor Data Fusion for Object Detection, Classification and Identification (Klein)</td>
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<tr>
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<td>Target Detection Algorithms for Hyperspectral Imagery (Nasrabadi)</td>
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Sign up today
Course fees increase after 8 April 2011
## IR Sensors and Systems

<table>
<thead>
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<th>Duration</th>
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<tr>
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<td>Engineering Approach to Imaging System Design (Holst) 8:30 am to 5:30 pm, $320 / $420, p. 11</td>
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<tr>
<td>SC728</td>
<td>Infrared Detectors (Dereniak) 8:30 am to 12:30 pm, $385 / $435, p. 10</td>
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<tr>
<td>SC835</td>
<td>Infrared Systems - Technology &amp; Design (Daniels) 8:30 am to 5:30 pm, $1035 / $1255, p. 12</td>
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<tr>
<td>SC1000</td>
<td>Introduction to Infrared and Ultraviolet Imaging Technology (Richards) 1:30 to 5:30 pm, $310 / $360, p. 15</td>
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</tr>
<tr>
<td>SC944</td>
<td>The Radiometry Case Files (Grant) 1:30 to 5:30 pm, $350 / $400, p. 14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Defense, Homeland Security, and Law Enforcement

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Duration</th>
<th>Fee 1</th>
<th>Fee 2</th>
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</thead>
<tbody>
<tr>
<td>SC719</td>
<td>Chemical &amp; Biological Detection: Overview of Point and Standoff Sensing Technologies (Gartner) 8:30 am to 12:30 pm, $275 / $325, p. 16</td>
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<tr>
<td>SC854</td>
<td>Scanning Microscopy in Forensic Science (Platok, Trimpe, McVicar, Postek) 8:30 am to 5:30 pm, $480 / $570, p. 17</td>
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<tr>
<td>SC952</td>
<td>Applications of Detection Theory (Carrano) 8:30 am to 5:30 pm, $480 / $570, p. 17</td>
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**NEW Courses:** SC713, SC728, SC835, SC1000, SC944.
<table>
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<th>Monday</th>
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**Imaging and Sensing**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Date and Time</th>
<th>Price Details</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC713</td>
<td>Engineering Approach to Imaging System Design (Holst)</td>
<td>8:30 am to 5:30 pm, $530 / $620, p. 21</td>
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<tr>
<td>SC950</td>
<td>Infrared Imaging Radiometry (Richards)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 24</td>
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<tr>
<td>SC157</td>
<td>MTF in Optical and Electro-Optical Systems (Ducharme)</td>
<td>8:30 am to 5:30 pm, $520 / $610, p. 20</td>
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<tr>
<td>SC952</td>
<td>Applications of Detection Theory (Carrano)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 24</td>
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<tr>
<td>SC178</td>
<td>Introduction to Radiometry and Photometry (Grant)</td>
<td>8:30 am to 12:30 pm, $390 / $440, p. 21</td>
<td></td>
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<tr>
<td>SC838</td>
<td>Laser Range Gated Imaging Techniques (Duncan)</td>
<td>1:30 to 5:30 pm, $275 / $325, p. 22</td>
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<tr>
<td>SC194</td>
<td>Multispectral and Hyperspectral Image Sensors (Lonheim)</td>
<td>8:30 am to 12:30 pm, $275 / $325, p. 21</td>
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<tr>
<td>SC1033</td>
<td>Optical Phased Array Technologies and Systems (Probst, McManamon)</td>
<td>8:30 am to 12:30 pm, $275 / $325, p. 21</td>
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<tr>
<td>SC1000</td>
<td>Introduction to Infrared and Ultraviolet Imaging Technology (Richards)</td>
<td>1:30 to 5:30 pm, $310 / $360, p. 25</td>
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<tr>
<td>SC946</td>
<td>Super Resolution in Imaging Systems</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 23</td>
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<tr>
<td>SC947</td>
<td>Cost-Conscious Tolerancing of Optical and IR Systems (Youngworth, Contreras)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 24</td>
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<tr>
<td>SC995</td>
<td>Target Detection Algorithms for Hyperspectral Imagery (Nasrabadi)</td>
<td>8:30 am to 12:30 pm, $275 / $325, p. 21</td>
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<tr>
<td>SC1031</td>
<td>Radar Micro-Doppler Signatures - Principles and Applications (Chen, Tahmoush)</td>
<td>1:30 to 5:30 pm, $275 / $325, p. 26</td>
<td></td>
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<tr>
<td>SC944</td>
<td>The Radiometry Case Files (Grant)</td>
<td>1:30 to 5:30 pm, $350 / $400, p. 23</td>
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**Laser Sensors and Systems**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<th>Price Details</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC167</td>
<td>Introduction to Laser Radar (Kamerman)</td>
<td>8:30 am to 12:30 pm, $275 / $325, p. 27</td>
<td></td>
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<tr>
<td>SC1032</td>
<td>Direct Detection Laser Radar Systems for Imaging Applications (Richmond, Cain)</td>
<td>8:30 am to 5:30 pm, $525 / $615, p. 30</td>
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<tr>
<td>SC1035</td>
<td>Military Laser Safety (Marshall)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 31</td>
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<tr>
<td>SC188</td>
<td>Laser Beam Propagation for Applications in Laser Communications, Laser Radar, and Active Imaging (Phillips, Andrews)</td>
<td>8:30 am to 5:30 pm, $610 / $700, p. 28</td>
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<tr>
<td>SC168</td>
<td>Advanced Coherent Laser Radars Design and Applications (Kamerman)</td>
<td>8:30 am to 5:30 pm, $275 / $325, p. 27</td>
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<tr>
<td>SC160</td>
<td>Precision Stabilized Pointing and Tracking Systems (Hilkert)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 27</td>
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<tr>
<td>SC1036</td>
<td>Diode Pumped Alkali Lasers (Perram)</td>
<td>8:30 am to 5:30 pm, $275 / $325, p. 32</td>
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<tr>
<td>SC1033</td>
<td>Optical Phased Array Technologies and Systems (Probst, McManamon)</td>
<td>8:30 am to 5:30 pm, $610 / $700, p. 31</td>
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<tr>
<td>SC1031</td>
<td>Radar Micro-Doppler Signatures - Principles and Applications (Chen, Tahmoush)</td>
<td>8:30 am to 5:30 pm, $275 / $325, p. 30</td>
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<tr>
<td>SC838</td>
<td>Laser Range Gated Imaging Techniques (Duncan)</td>
<td>8:30 am to 5:30 pm, $275 / $325, p. 28</td>
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<tr>
<td>SC997</td>
<td>High Power Laser Beam Quality (Rosa)</td>
<td>8:30 am to 5:30 pm, $275 / $325, p. 29</td>
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<tr>
<td>SC947</td>
<td>Cost-Conscious Tolerancing of Optical and IR Systems (Youngworth, Contreras)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 28</td>
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**Sensor Data and Information Exploitation**

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<tr>
<th>Course Code</th>
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<th>Price Details</th>
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<tbody>
<tr>
<td>SC1031</td>
<td>Radar Micro-Doppler Signatures - Principles and Applications (Chen, Tahmoush)</td>
<td>8:30 am to 5:30 pm, $275 / $325, p. 34</td>
<td></td>
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<tr>
<td>SC994</td>
<td>Multisensor Data Fusion for Object Detection, Classification and Identification (Klein)</td>
<td>8:30 am to 5:30 pm, $550 / $640, p. 33</td>
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<tr>
<td>SC1035</td>
<td>Military Laser Safety (Marshall)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 35</td>
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<tr>
<td>SC158</td>
<td>Fundamentals of Automatic Target Recognition (Sadjadi)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 32</td>
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<tr>
<td>SC181</td>
<td>Predicting Target Acquisition Performance of Electro-Optical Imagers (Vollmerhausen)</td>
<td>8:30 am to 5:30 pm, $520 / $610, p. 33</td>
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<tr>
<td>SC194</td>
<td>Multispectral and Hyperspectral Image Sensors (Lonheim)</td>
<td>8:30 am to 12:30 pm, $275 / $325, p. 33</td>
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<tr>
<td>SC995</td>
<td>Target Detection Algorithms for Hyperspectral Imagery (Nasrabadi)</td>
<td>8:30 am to 5:30 pm, $480 / $570, p. 34</td>
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### Daily Course Schedule

#### Signal, Image, and Neural Net Processing

- **SC066 Fundamentals of Electronic Image Processing** (Weeks) 8:30 am to 5:30 pm, $550 / $640, p. 35
- **SC994 Multisensor Data Fusion for Object Detection, Classification and Identification** (Klein) 8:30 am to 5:30 pm, $550 / $640, p. 37
- **SC846 Super Resolution in Imaging Systems** (Bagheri, Javidi) 8:30 to 5:30 pm, $480 / $570, p. 36
- **SC972 Applications of Detection Theory** (Carrano) 8:30 am to 5:30 pm, $480 / $570, p. 37

#### Sensing for Industry, Environment, and Health

- **SC719 Chemical & Biological Detection: Overview of Point and Standoff Sensing Technologies** (Gardner) 8:30 am to 12:30 pm, $275 / $325, p. 38
- **SC952 Applications of Detection Theory** (Carrano) 8:30 am to 5:30 pm, $480 / $570, p. 36
- **SC955 Target Detection Algorithms for Hyperspectral Imagery** (Nasrabadi) 8:30 am to 5:30 pm, $480 / $570, p. 37

#### Information Systems and Networks: Processing, Fusion, and Knowledge Generation

- **SC994 Multisensor Data Fusion for Object Detection, Classification and Identification** (Klein) 8:30 am to 5:30 pm, $550 / $640, p. 40
- **SC952 Applications of Detection Theory** (Carrano) 8:30 am to 5:30 pm, $480 / $570, p. 40

#### Innovative Defense and Security Applications for Displays

- **SC159 Head-Mounted Displays: Design and Applications** (Melzer, Browne) 8:30 am to 5:30 pm, $515 / $605, p. 41

#### Unmanned, Robotic, and Layered Systems

- **SC996 Introduction to GPS Receivers** (Zhu) 8:30 am to 12:30 pm, $275 / $325, p. 42
- **SC952 Applications of Detection Theory** (Carrano) 8:30 am to 5:30 pm, $480 / $570, p. 42
- **SC549 Incorporating GPS Technology into Commercial and Military Applications** (Zhu) 1:30 to 5:30 pm, $275 / $325, p. 41
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<thead>
<tr>
<th>Day</th>
<th>Course Title</th>
<th>Instructor(s)</th>
<th>Time</th>
<th>Fee</th>
<th>Pages</th>
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<tr>
<td>Monday</td>
<td>Emerging Technologies</td>
<td></td>
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<td>SC1034 Lab-on-a-Chip Technology - Towards Portable Detection Systems</td>
<td>Gärtner</td>
<td>8:30 am to 12:30 pm</td>
<td>$275 / $325</td>
<td>43</td>
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<tr>
<td>Tuesday</td>
<td>Scanning Microscopy and Forensics</td>
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<tr>
<td></td>
<td>SC954 Scanning Microscopy in Forensic Science</td>
<td>Piatak, Trimpe, McVicar, Postek</td>
<td>8:30 am to 5:30 pm</td>
<td>$480 / $570</td>
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<tr>
<td>Wednesday</td>
<td>Optical and Optomechanical Engineering</td>
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<td></td>
<td>SC156 Basic Optics for Engineers</td>
<td>Ducharme</td>
<td>8:30 am to 5:30 pm</td>
<td>$520 / $610</td>
<td>45</td>
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<td>SC960 Infrared Imaging Radiometry</td>
<td>Richards</td>
<td>8:30 am to 5:30 pm</td>
<td>$480 / $570</td>
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<td>SC014 Introduction to Optomechanical Design</td>
<td>Vukobratovich</td>
<td>8:30 am to 5:30 pm</td>
<td>$890 / $1110</td>
<td>44</td>
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<td>SC1010 Introduction to Optical Alignment Techniques</td>
<td>Ruda</td>
<td>8:30 am to 5:30 pm</td>
<td>$890 / $1110</td>
<td>44</td>
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<td>SC178 Introduction to Radiometry and Photometry</td>
<td>Grant</td>
<td>1:30 to 5:30 pm</td>
<td>$310 / $360</td>
<td>49</td>
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<td>WS809 Basic Optics for Non-Optics Personnel</td>
<td>Harding</td>
<td>1:30 to 4:00 pm</td>
<td>$100 / $150</td>
<td>49</td>
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<td>WS810 Optomechanical Analysis</td>
<td>Hatheway</td>
<td>8:30 am to 5:30 pm</td>
<td>$480 / $570</td>
<td>47</td>
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<td>WS947 Cost-Conscious Tolerancing of Optical and IR Systems</td>
<td>Youngworth, Contreras</td>
<td>8:30 am to 5:30 pm</td>
<td>$480 / $570</td>
<td>48</td>
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<td></td>
<td>SC944 The Radiometry Case Files</td>
<td>Grant</td>
<td>1:30 to 5:30 pm</td>
<td>$380 / $400</td>
<td>47</td>
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<td>SC659 Understanding Reflective Optical Design</td>
<td>Contreras</td>
<td>8:30 am to 5:30 pm</td>
<td>$480 / $570</td>
<td>46</td>
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<tr>
<td>Thursday</td>
<td>Business &amp; Professional Development</td>
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<td>WS951 Leading Successful Product Innovation</td>
<td>Carrano</td>
<td>8:30 am to 12:30 pm</td>
<td>$275 / $325</td>
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<td></td>
<td>WS933 Complying with the ITAR: A Case Study</td>
<td>Scarlett</td>
<td>8:30 am to 12:30 pm</td>
<td>$275 / $325</td>
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<td>WS1037 Advanced Topics in U.S. International Trade Regulations</td>
<td>Scarlett</td>
<td>8:30 am to 12:30 pm</td>
<td>$275 / $325</td>
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<tr>
<td>Friday</td>
<td>BS609 Basic Optics for Non-Optics Personnel</td>
<td>Harding</td>
<td>1:30 to 4:00 pm</td>
<td>$100 / $150</td>
<td>51</td>
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Sign up today
Course fees increase after 8 April 2011
Transfer function, slit response function, random noise, uniformity, fixed performance parameters discussed include resolution, responsivity, aperiodic methodologies are used for visible and thermal imaging systems. Performance parameters discussed include resolution, responsivity, aperiodic transfer function, slit response function, random noise, uniformity, fixed pattern noise, modulation transfer function (MTF), contrast transfer function (CTF), minimum resolvable temperature (MRT), and the minimum resolvable contrast (MRC). The eye’s spatial and temporal integration allows perception of images whose signal-to-noise ratio (SNR) is less than unity. Since all imaging system spatially sample the scene, sampling artifacts occur in all imagery and therefore affects all measurements. Sampling can significantly affect MRT and MTF tests. Low SNR and sampling effects are interactively demonstrated. This course describes the most common testing techniques. Equally important is identifying those parameters that adversely affect results.

LEARNING OUTCOMES
This course will enable you to:
• write concise test procedures with unambiguous system specifications
• identify all appropriate test parameters
• describe the radiometric relationship between delta-T and spectral radiance
• differentiate between observer variability and system response during MRC and MRT testing
• describe the difference between the CTF and the MTF
• learn about the latest MTF measurement techniques
• discern the difference between poor system performance, peculiarities of the system under test, and measurement errors
• assess how sampling affects test results
• appreciate the benefits and short comings of fully automated testing
• identify parameters that can lead to poor results.
• learn about evolving standardized testing concepts

INTENDED AUDIENCE
The course is for managers, specification writers, and test engineers involved with all phases of imaging system characterization ranging from satisfying customer requirements to ensuring that specifications are unambiguous and testable.

INSTRUCTOR
Gerald Holst is an independent consultant for imaging system analysis and testing. He was a technical liaison to NATO, research scientist for DoD, and a member of the Lockheed-Martin senior technical staff. Dr. Holst has chaired the SPIE conference Infrared Imaging Systems: Design, Analysis, Modeling and Testing since 1989. He is author of over 30 journal articles and 6 books (published by SPIE and/or JCD Publishing). Dr. Holst is a member of ASA and is a SPIE Fellow.

target acquisition and use V50 as a discrimination metric. Limitations and applications of NVTherm and NVThermIP are discussed with a brief demonstration of the models. Selection and optimization of a specific sensor depends upon a myriad of radiometric, spectral, and spatial parameters (e.g., target signature, atmospheric conditions, optics f-number, field-of-view, and detector responsivity). MTFs and their effect on imagery are interactively demonstrated. Spatial sampling is present in all cameras. Super-resolution reconstruction and microscan minimize sampling artifacts. Several optimization examples are discussed (case study examples).

LEARNING OUTCOMES
This course will enable you to:
• use the correct MTFs for image chain analysis
• describe the radiometric relationship between delta-T and spectral radiance
• compare the differences among scanning, staring, and microscan staring array performance
• recognize the limitations of back-of-the-envelope approximations such as resolution and sensitivity
• identify the subsystem (e.g., motion, optics, detector, electronics, and display) that limits performance
• appreciate limitations of range performance predictions (target acquisition predictions)
• determine if mid-wave (MWIR) or long-wave (LWIR) infrared is appropriate for your application
• appreciate the value of graphs rather than a table of numbers
• be conversant with the myriad of technological terms
• become a smart buyer, analyst, and/or user of imaging systems

INTENDED AUDIENCE
This course is intended for engineers, managers, and buyers who want to understand the wealth of information available from imaging system end-to-end analysis. It is helpful if the students are familiar with linear system theory (MTF analysis).

INSTRUCTOR
Gerald Holst is an independent consultant for imaging system analysis and testing. He was a technical liaison to NATO, research scientist for DoD, and a member of the Lockheed-Martin senior technical staff. Dr. Holst has chaired the SPIE conference Infrared Imaging Systems: Design, Analysis, Modeling and Testing since 1989. He is author of over 30 journal articles and 6 books (published by SPIE and/or JCD Publishing). Dr. Holst is a member of OSA and is a SPIE Fellow.


Introduction to Radiometry and Photometry
SC178

Course level: Introductory
CEU .35 Member $390 / Non-member $440 USD
Monday 8:30 am to 12:30 pm

In this half-day course the basic quantities of radiometry, their units, and their relationships to electro-magnetic field quantities are presented. Photometry, its units, and conversion factors to older units are also addressed. The course covers the fundamentals of blackbody radiation generation and transfer. The basic equations needed to set up and solve problems are discussed.

The course introduces radiometric and photometric sources, detectors of optical radiation, instrumentation, and calibration. The supplementary textbook, Introduction to Radiometry and Photometry by Ross McCluney, is provided with the course and offers more detail in detector optical/ electrical characterization, color theory, and optical properties of specific materials.

This course is an ideal lead-in to SC944 The Radiometry Case Files, which provides many applied examples of the concepts introduced here.

LEARNING OUTCOMES
This course will enable you to:
• learn the methodology used for quantifying and describing electromagnetic radiation from the extreme UV through the visible portions of the spectrum and into the far IR
• become conversant with the concepts, terminology, and units of both radiometry and photometry
• master key radiometric laws and approximations
• master the basics of photometry, the system of terminology and units used whenever the eye is the detector
• describe the characterization of optical properties of surfaces, materials, and objects
• gain insight into the design and calibration of radiometers and photometers

INTENDED AUDIENCE
This course is for engineers and scientists who deal with electromagnetic radiation who need to quantify this radiation using international standard units and terminology. The course is for teachers, students, and researchers interested in using proper methods, terminology, symbols, and units in their courses and their research work. It is also for practitioners solving problems in radiation transfer, and in measuring radiant and luminous flux in optical systems and in nature.

INSTRUCTOR
Barbara Grant is the co-author, with Jim Palmer, of The Art of Radiometry. For more than twenty years she has applied her engineering skills to solve problems in industries as diverse as aerospace and indoor tanning. A consultant in electro-optics, she received the M.S. degree in Optical Sciences from the University of Arizona and two NASA awards for her work on the GOES weather satellite imager and sounder. Her previous work for SPIE includes developing and chairing a special session on FLIR image analysis.

COURSE PRICE INCLUDES the text Introduction to Radiometry and Photometry (Artech House, 1994) by Ross McCluney.

Predicting Target Acquisition Performance of Electro-Optical Imagery
SC181
Course level: Advanced
CEU .65 Member $520 / Non-member $610 USD
Tuesday 8:30 am to 5:30 pm

This course describes how to predict and evaluate electro-optical (EO) imager performance. Metrics that quantify imager resolution are described. The detection, recognition, and identification tasks are discussed, and the meaning of acquisition probabilities is explained. The basic theory of operation of thermal imagers, image intensifiers, and video cameras is presented. This course describes how to quantify the resolution and noise characteristics of an EO imager. The theory and analysis of sampled imagers is emphasized. Image quality metrics are described, and the relationship between image quality and target acquisition performance is explained. The course provides a complete overview of how to analyze and evaluate the performance of EO imagers.

LEARNING OUTCOMES
This course will enable you to:
• describe what a target acquisition model does
• describe the operation of thermal sensors, video cameras and other EO imagers
• analyze the impact of sampling on targeting performance
• evaluate the targeting performance of an EO imager

INTENDED AUDIENCE
This course is intended for the design engineer or system analyst who is interested in quantifying the performance of EO imagers. Some background in linear systems analysis is helpful but not mandatory.
Courses

INSTRUCTOR
Richard Vollmerhausen recently retired from the Army’s Night Vision and Electronic Sensors Directorate. He is currently consulting. Mr. Vollmerhausen is the developer of the current generation of target acquisition models used by the Army.


Infrared Window and Dome Materials
SC214
CEU .65 Member $545 / Non-member $635 USD
Tuesday 8:30 am to 5:30 pm
This course presents an overview of the optical, thermal and mechanical characteristics of infrared-transmitting window and dome materials. Other topics include thermal shock response, rain and particle erosion, protective coatings, antireflection coatings, electromagnetic shielding, proof testing, and fabrication of optical ceramics. The course concludes with a brief discussion of sapphire and diamond as infrared materials.

LEARNING OUTCOMES
This course will enable you to:
• identify the optical, thermal and mechanical characteristics of a window material that are critical to its selection for a particular application
• predict optical, thermal and mechanical performance of window materials under a range of conditions, based on tabulated data
• compare the strengths and weaknesses of different materials and different coatings for a given application
• describe the principal methods by which optical ceramics are manufactured

INTENDED AUDIENCE
The course is directed at engineers, scientists, managers and marketing personnel who need an introduction to properties, performance, and manufacture of windows and domes. A basic degree in engineering or science is the expected background, but care will be taken to provide introductory background information for each topic.

INSTRUCTOR
Daniel C. Harris is a Senior Scientist at the Naval Air Warfare Center, China Lake, California, where he directs programs in optical materials.

COURSE PRICE INCLUDES the text Materials for Infrared Windows and Domes (SPIE Press, 1999) by Daniel Harris. Attendees should bring a calculator to this course.

Infrared Detectors
SC278
Course level: Introductory
CEU .35 Member $385 / Non-member $435 USD
Monday 8:30 am to 12:30 pm
This course will provide a broad and useful background on optical detectors, both photon and thermal, with a special emphasis placed on the infrared detectors. Discussion of optical detection will be stressed. The fundamentals of responsivity (RI), noise equivalent power (NEPI) and specific detectivity (D') will be discussed. These figures of merit will be extended to photon noise limited performance and Johnson noise limitations (RA product). Discussion of optical detector fundamentals will be stressed. To aid the attendee in selecting the proper detector choice, the detailed behavior of the more important IR detector materials will be described in detail. Newer technologies such as quantum well infrared photodetectors and blocked impurity bands as well as IR detectors will be covered briefly.

LEARNING OUTCOMES
This course will enable you to:
• understand optical radiation detection processes
• explain noise mechanisms related to optical detectors
• derive figures of merit for optical detectors
• compare BLIP condition to RA product performance
• evaluate and discuss HgCdTe detectors’ unique features
• understand why room temperature thermal detectors are so important
• derive the wavelength dependence of detectors

INTENDED AUDIENCE
This class is directed at people who need to learn more about optical detectors from a user point of view. It will give the student insight into the optical detection process as well as what is available to application engineers, advantages, shortcomings, and pitfalls.

INSTRUCTOR
Eustace Dereniak is a Professor of Optical Sciences and Electrical and Computer Engineering at the Univ. of Arizona, Tucson, Arizona. His research interests are in the areas of detectors for optical radiation, imaging spectrometers and imaging polarimeters instrument development. Dereniak is a co-author of several textbooks and has authored book chapters. His publications also include over 100 authored or co-authored refereed articles. He spent many years in industrial research with Raytheon, Rockwell International, and Ball Brothers Research Corporation. He has taught extensively and is a Fellow of the SPIE and OSA, and a member of the Board of Directors of SPIE.


Understanding Reflective Optical Design
SC659
Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm
This course provides attendees with a working knowledge of reflective optical system design. The morning session concentrates on analytical differences from refractive systems, including basic 1st order layout considerations and optimization techniques. It provides an overview of the conceptual development of various reflective designs, and provides an understanding of the basic capabilities, advantages and disadvantages of many common reflective forms. The afternoon session offers insights into departing from symmetry, understanding aberration forms with off axis apertures, a discussion of segmented mirror systems, and a brief overview of assembly and test considerations and manufacturing techniques.

LEARNING OUTCOMES
This course will enable you to:
• develop and analyze the appropriate set of 1st order parameters for reflective systems
• identify the advantages and constraints of various common reflective forms
• list analysis parameters unique to reflective system design
• trace the logical progression of reflective system from the single to multiple mirrors
• establish reasonable starting point layouts for 3 mirror design forms
• identify situations that may call for departing from symmetry in the design and understand the advantages and limitations of this technique
• recognize aberration forms in off-axis apertures and how to mitigate them
• classify the basic advantages and constraints of designs with segmented mirrors
• identify key strategies for integration I&T of reflective architectures
• describe fundamental manufacturing techniques and considerations, including diamond turning methods and mirror material properties
LEARNING OUTCOMES

This course will enable you to:

- understand the trade-off between MTF and aliasing
- use MTFs, resolution, sensitivity, and sampling concepts for system design
- determine which subsystem limits system performance and why
- equivalently determine if your system is detector-limited or optics-limited
- determine if your system is resolution or sensitivity limited
- identify the subsystem components that affect resolution and sensitivity
- determine if your system is resolution or sensitivity limited
- equivalently determine if your system is detector-limited or optics-limited
- determine which subsystem limits system performance and why
- understand sampling artifacts (Nyquist frequency limit, aliasing, Moiré patterns, and variations in object edge location and width)
- use MTFs, resolution, sensitivity, and sampling concepts for system optimization
- understand the trade-off between MTF and aliasing

INTENDED AUDIENCE

This material is intended for anyone who needs to design or specify reflective optical systems, or who works with optical designers on a regular basis. A basic understanding of 1st order optics is helpful; a brief overview will be provided. No optical design experience is required, but a basic knowledge of optical aberrations will be assumed for the optical design specific discussions. The more in depth, design oriented portions of the course will include summary information valuable to engineers in non-optical disciplines. Those who have either little optical design experience or just minimal reflective design experience will find this course especially valuable.

INSTRUCTOR

James Contreras is a principal optical engineer at Exotic Electro-Optics, a subsidiary of IL-VI Incorporated in Murrieta, CA. He has extensive experience in the design, analysis and fabrication of reflective optical systems for a variety of applications ranging from military platforms to the James Webb Space Telescope. His current projects include conceptual optical design of multiple wavelength band sensors for military and commercial applications, design for manufacturability of existing products, and investigation of replicated mirror technologies.
Courses

**Introduction to Optical and Infrared Sensor Systems**

**SC789**  
**Course level:** Introductory  
**CEU .65 Member $480 / Non-member $570 USD**  
**Friday 8:30 am to 5:30 pm**

This course provides a broad introduction to optical (near UV-visible) and infrared sensor systems, with an emphasis on systems used in defense and security. Topics include both passive imagers and active laser radars (lidar/ladar). We begin with a discussion of radiometry and radiometric calculations to determine how much optical power is captured by a sensor system. We survey atmospheric propagation and phenomenology (absorption, emission, scattering, and turbulence) and explore how these issues affect sensor systems. Finally, we perform signal calculations that consider the source, the atmosphere, and the optical system and detector, to arrive at a signal-to-noise ratio for typical passive and active sensor systems. These principles of optical radiometry, atmospheric propagation, and optical detection are combined in examples of real sensors studied at the block-diagram level. Sensor system examples include passive infrared imagers, polarization imagers, and hyperspectral imaging spectrometers, and active laser radars (lidars or ladders) for sensing distributed or hard targets. The course organization is approximately one third on the radiometric analysis of sensor systems, one third on atmospheric phenomenology and detector parameters, and one third on example calculations and examination of sensor systems at the block-diagram level.

**LEARNING OUTCOMES**

This course will enable you to:

- understand and use radiometry for describing and calculating the flow of optical energy in an optical or infrared sensor system
- determine the radiometric throughput of sensor systems
- describe atmospheric phenomenology relevant to propagation of optical and infrared radiation
- explain how the atmosphere affects the performance of sensor systems
- use detector parameters with radiometric calculations to predict the signal received by passive and active sensors
- calculate signal-to-noise ratio for typical sensor systems
- understand real-world sensor systems at the block-diagram level
- explain the difference between and important concepts of passive reflection-based and emission-based imaging
- understand the basic operating principles of passive imagers and active laser radar (lidar/ladar) systems for distributed and solid target sensing

**INTENDED AUDIENCE**

Scientists, engineers, technicians, or managers who find themselves working on (or curious about) optical (uv-vis) and infrared sensor systems without formal training in this area. Undergraduate training in engineering or science is assumed.

**INSTRUCTOR**

Joseph Shaw has been developing optical remote sensing systems and using them in environmental and military sensing for two decades, first at NOAA and currently as professor of electrical engineering and physics at Montana State University. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization’s Vaisala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona. Dr. Shaw is a fellow of both the OSA and SPIE.

**Infrared Systems - Technology & Design**

**SC835**  
**Course level:** Advanced  
**CEU 1.30 $1035 / Non-member $1255 USD**  
**Monday 8:30 am to 5:30 pm**

This course covers the range of topics necessary to understand the theoretical principles of modern infrared-technology. It combines numerous engineering disciplines necessary for the development of infrared systems. Practical engineering calculations are highlighted, with examples of trade studies illustrating the interrelationships among the various hardware characteristics.

This course is comprised of four sections:

Section 1 introduces the geometrical optics concepts including image formation, stops and pupils, thick lenses and lens combinations, image quality, and the properties of infrared materials.

Section 2 covers the essentials of radiometry necessary for the quantitative understanding of infrared signatures and flux transfer. These concepts are then developed and applied to flux-transfer calculations for blackbody, graybody, and selective radiator sources. Remote temperature calibrations and measurements are then used as an illustration of these radiometric principles.

Section 3 is devoted to fundamental background issues for optical detection-processes. It compares the characteristics of cooled and uncooled detectors with an emphasis on spectral and blackbody reponsivity, detectivity (D*), as well as the noise mechanisms related to optical detection. The detector parameters and capabilities of single detectors and third generation focal plane arrays (FPAs) are analyzed. With this acquired background, Section 4 considers the systems-design aspects of infrared imagers. The impact of scan format on signal-to-noise ratio is described, and the engineering tradeoffs inherent in the development of infrared search and track (IRST) systems are explained. Figures of merit such as MTF, NETD, and MRTD of staring arrays are examined for the performance metrics of thermal sensitivity and spatial resolution of thermal imaging systems (TIS). Contrast threshold functions based on Johnson and visible cycles (often denoted as N- and V-cycles) are specified. The interrelationships among the design parameters are identified through trade-study examples.

**LEARNING OUTCOMES**

This course will enable you to:

- learn the principles and fundamentals of infrared optical design
- choose the proper infrared materials suite for your applications
- quickly execute flux-transfer calculations
- calibrate infrared sources and target signatures
- recognize the importance of background in thermal signatures
- have an appreciation for the capacity of infrared systems and learn the interaction of its critical components (optics, detectors, and electronics) in the production of a final infrared image
- assess the influence of noise mechanisms related to optical detection
- comprehend the fundamental response mechanisms and differences between cooled and uncooled single detectors as well as focal plane arrays (FPAs)
- comprehend the central theory behind third generation infrared imagers
- define and use common descriptors for detector and system performance (R, D*, NEP, NEI, MTF, NETD, and MRTD)
- estimate system performance given subsystem and component specifications
- apply design tradeoffs in both infrared search and track systems (IRST) and thermal-imaging systems (TIS)
- carry out the preliminary design of infrared systems for different thermal applications

**INTENDED AUDIENCE**

This course is directed to the practicing engineers and/or scientists who require both theoretical and effective practical technical information to design, build, and/or test infrared systems in a wide variety of thermal applications. A background at the bachelor’s level in engineering is high-
Laser Range Gated Imaging Techniques

SC838
Course level: Intermediate
CEU .35 Member $275 / Non-member $325 USD
Tuesday 1:30 to 5:30 pm

This course provides attendees with a detailed background in the benefits and applications of laser gated imaging, also known as Burst Illumination (BIL). This technique covers the use of laser illumination in conjunction with focal plane arrays to improve the ability to detect and identify objects across a wide range of scenarios. The course concentrates on the components involved in such a system, the phenomena that are unique to laser illumination, and the performance one can expect from laser illuminated sensing. Practical examples to demonstrate the benefits and limitations of these systems will be covered. At the end of this course, you will be knowledgeable in the types of sources and sensors that can be used and the image processing that can be applied to optimize the system performance.

LEARNING OUTCOMES
This course will enable you to:
- compare the advantages and limitations of laser gated imaging systems
- describe various components within a laser gated imaging system
- compare the relative merits of gated detector technologies
- identify the parameters that influence system performance in resolution, SNR and laser characteristics
- analyze range performance predictions for different laser gated imaging systems
- judge atmospheric effects and their mitigation in laser illuminated imaging

INTENDED AUDIENCE
Engineers, scientists and managers who want to improve their understanding of the use of laser illumination for improved imaging techniques and the benefits of gated sensors. No background in laser gated imaging is assumed, although some familiarity with basic concepts of imaging systems will be advantageous.

INSTRUCTOR
Arnold Daniels is a senior lead engineer with extensive experience in the conceptual definition of advance infrared, optical, and electro-optical systems. His background consists of technical contributions to applications for infrared search & track, thermal imaging, and ISR systems. Other technical expertise include infrared radiometry (testing and measurements), infrared test systems (i.e., MTF, NETD, and MRTD), thermographic nondestructive testing (TNDT), optical design, precision optical alignment, stray light analysis, adaptive optics, Fourier analysis, image processing, and data acquisition systems. He earned an M.S. in Electrical Engineering from the University of Tel-Aviv and a doctorate in Electro-Optics from the School of Optics (CREOL) at the University of Central Florida. In 1995 he received the Rudolf Kingslake medal and prize for the most noteworthy original paper to appear in SPIE’s Journal of Optical Engineering. He is presently developing direct energy laser weapon systems for defense applications.

INSTRUCTOR
Stuart Duncan is Chief Technical Officer with SELEX Sensors and Airborne Systems in the United Kingdom and has been involved in Electro Optic System Design and Integration for over 24 years. He is a Masters graduate from Imperial College, London.
metrics for evaluating and comparing performance, and how key factors influence those metrics. The course also explores the limits of performance of uncooled IR imaging, as well as trends to be expected in future products.

**LEARNING OUTCOMES**

This course will enable you to:
- describe the operation of uncooled IR detectors and basic readout circuits
- evaluate performance in terms of responsivity, noise, noise equivalent temperature difference, minimum resolvable temperature, and response time
- gauge the fundamental limits to their performance, including temperature-fluctuation noise and background fluctuation noise
- compare theory with measured performance of the uncooled arrays
- evaluate practical issues and limitations of current technology
- ascertain the state of development of new IR technologies by asking the right questions
- differentiate well-developed concepts from ill-conceived notional concepts
- identify the uncooled IR technology best suited to your needs
- assess the performance potential of novel IR imaging technologies
- evaluate quantitatively the performance of a wide variety of uncooled IR detectors
- summarize construction details from the technical literature.

**INTENDED AUDIENCE**

This material is intended for engineers, scientists, and managers who need a background knowledge of uncooled IR technologies, for those who need to be able to evaluate those technologies for usefulness in particular applications, and for those working in the field who wish to deepen their knowledge and understanding. Anyone concerned with current and future directions in thermal imaging or involved in the development of IR detector technology or advanced uncooled IR system concepts will find this course valuable. The course has a significant mathematical content designed to illustrate the origin of the principles involved, but knowledge of the mathematics is not required to understand the concepts and results.

**INSTRUCTOR**

Charles Hanson has a Ph.D. in theoretical solid-state physics and is the CTO for Infrared Products at L-3 Communications Electro-Optical Systems. He has held government and industrial positions in infrared imaging for more than 40 years. He is a past chairman of Military Sensing Symposia (MSS) Passive Sensors and is presently a member of the SPIE Infrared Technology and Applications program committee.


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**The Radiometry Case Files**

**SC944**

**Course level:** Introductory  
**CEU .35 Member $350 / Non-member $400 USD**  
**Monday 1:30 to 5:30 pm**

This course takes basic radiometric principles and applies them to calculate the amount of radiation reaching a system’s entrance aperture or focal plane for a variety of source-system combinations. It provides a wide array of examples from which solutions to related problems may be drawn. It encompasses the UV, visible, and infrared regions of the electromagnetic spectrum, and includes several cases taken directly from the instructor’s industrial experience.

Typical applications to be addressed include solar and overcast sky irradiance, IR system calibration, tanning lamp output, lighting illumination, sensor signals from specular and diffuse reflectors, star detection on orbit, solar simulators and integrating spheres.

**LEARNING OUTCOMES**

This course will enable you to:
- identify approaches to problem-solving based on source and geometry considerations
- evaluate the amount of light received from single and multiple sources
- determine the effects of source material properties on calculations
- apply atmospheric and system spectral response characteristics to solution formulation
- operate a radiation slide rule
- qualify the limitations of your solution

**INTENDED AUDIENCE**

This class is designed for the practicing engineer or technologist who is expected to solve radiometric problems but is unsure what factors to identify in formulating a solution, or where to locate examples of similar problems. Though taught at an introductory level, the course assumes a basic familiarity with radiometric terminology.

**INSTRUCTOR**

Barbara Grant is the co-author, with Jim Palmer, of *The Art of Radiometry*. For more than twenty years she has applied her engineering skills to solve problems in industries as diverse as aerospace and indoor tanning. A consultant in electro-optics, she received the M.S. degree in Optical Sciences from the University of Arizona and two NASA awards for her work on the GOES weather satellite imager and sounder. Her previous work for SPIE includes developing and chairing a special session on FLIR image analysis.

**COURSE PRICE INCLUDES** the text *The Art of Radiometry* (SPIE Press, 2009) by James M. Palmer and Barbara G. Grant.

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**Cost-Conscious Tolerancing of Optical and IR Systems**

**SC947**

**Course level:** Introductory  
**CEU .65 Member $480 / Non-member $570 USD**  
**Wednesday 8:30 to 5:30 pm**

The purpose of this course is to present concepts, tools, and methods that will help attendees determine optimal tolerances for opto-mechanical systems in optical applications. Detailed topics in the course apply to all volumes of systems being developed - from single systems to millions of units. The importance of tolerancing throughout the design process is discussed in detail, including determining robustness of the specification and design for manufacture and operation. The course also provides a background to effective tolerancing with discussions on variability and relevant applied statistics. A treatment of third-order aberrations is included, with emphasis on understanding their origins and how to influence cost and production yield by considering their impacts. Tolerance analysis and assignment with strong methodology and examples are discussed, including the development of a design trade for a simple IR system. References and examples are included to help researchers, designers, engineers, and technicians practically apply the concepts to plan, design, engineer, and build high-quality cost-competitive optical systems.

**LEARNING OUTCOMES**

This course will enable you to:
- identify key system requirements for tolerancing
- develop insight into cost and sensitivity factors early in the design process
- define variability and comprehend its impact on nominal systems
- utilize fundamental applied statistics in tolerancing
- construct tolerance analysis budgets
- perform detailed tolerance analysis
- summarize different design of experiment and statistical process control strategies

**INTENDED AUDIENCE**

This material is intended for managers, engineers, and technical staff involved in product design from concept through manufacturing.
This material is intended for engineers, scientists, graduate students and technical persons that are new to infrared and ultraviolet imaging and want a very basic, qualitative overview of the fields with minimal mathematics. Little to no mathematical background is required.

INSTRUCTOR
Austin Richards is a senior research scientist at FLIR Commercial Vision Systems in Santa Barbara, CA. He holds a PhD in Astrophysics from UC Berkeley, and has worked in the commercial infrared industry for over 10 years. He is also the CTO of Oculus Photonics, a small company devoted to near-ultraviolet imaging systems manufacturing, sales and support. Richards is the author of the SPIE monograph Alien Vision: Exploring the Electromagnetic Spectrum with Imaging Technology and an adjunct professor at the Brooks Institute of Photography in Santa Barbara.

Military Laser Safety

SC1035

Course level: Introductory
CEU .65 Member $480 / Non-member $570 USD
Wednesday 8:30 am to 5:30 pm

This course explains the basic hazards associated with the use of lasers commonly encountered by military and law enforcement personnel, with particular emphasis on operation in an outdoor environment. Both laser classification and certification of laser products will be covered. The Department of Defense has an exemption from the Food and Drug Administration that allows manufacturers to produce military specific laser devices not available to the general public. The rules for using the Department of Defense exemption or obtaining a variance to purchase these special purpose products are explained.

LEARNING OUTCOMES
This course will enable you to:
• describe how a laser could cause personal injury to either the eye or skin
• describe how laser exposure limits were developed
• describe visual interference levels
• describe nominal ocular hazard distance and nominal skin hazard distance
• list differences in laser classification according to the:
  • Food and Drug Administration (FDA),
  • International Electrotechnical Commission (IEC), and
  • American National Standards Institute (ANSI)
• describe eye protection specifications for glasses and filters, such as optical density and visual transmission
• classify military applications of lasers, such as range finding, designating targets, dazzling
• manufacture and sell a federally compliant laser product
• learn the origin of the military exemption - 76 EL-01 DOD
• know whether your product meets the criteria for a military specific product
• know what features are required for a military specific product
• purchase a military specific laser product from a manufacturer
• dispose of a military specific laser product that has been manufactured under 76 EL-01 DOD
• evaluate the variance process for making a product not fully in compliance with federal product performance standards
• request evaluation of a system designed for joint military service use

INTENDED AUDIENCE
Engineers, scientists, technicians and managers involved in the development of laser-based defense related products who need to understand the regulatory process for certifying these devices. Military and civilian personnel, involved in operations, range safety, and procurement, who want to understand the safety issues involved with the field use of lasers.

INSTRUCTOR
Wesley Marshall has been involved with military laser safety for almost 40 years and has been involved with the development of laser safety standards and military products. He has evaluated hundreds of military specific laser systems and has published dozens of articles in peer reviewed technical journals. He has taught laser safety courses for the US Army, Occupational Safety and Health Administration, North Atlantic Treaty Organization, Laser Institute of America, and Rockwell Laser Industries. For over three years, he served as manager for the Army Institute of Health Laser/Optical Radiation Program (formerly known as CHPPM).

Defense, Homeland Security, and Law Enforcement

Chemical & Biological Detection: Overview of Point and Standoff Sensing Technologies

SC719

Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Monday 8:30 am to 12:30 pm

This course introduces chemical and biological detection and identification techniques which are commonly utilized for military and civil applications. Remote and sampled detection, discrimination, and identification techniques are introduced with design parameters and performance models. A sampling of specific technology applications for chemical point, chemical standoff, biological point, and biological standoff sensing will be described. These technologies include Mass Spectrometry, Ion Mobility Spectrometry, Raman Spectroscopy, Fourier Transform Infrared Spectroscopy, Differential Absorption Lidar, Laser-Induced Fluorescence, Laser-Induced Breakdown Spectroscopy and others. The course will include a brief overview of chemical and biological agents and features which may be interrogated by detection systems.

LEARNING OUTCOMES
This course will enable you to:
• list and analyze chemical/biological detection and discrimination techniques
• describe the space for point and standoff detection
• estimate spatial, spectral, and temporal variations in chemical/biological media
• formulate fundamental design and performance equations for chemical/biological sensors
• compare mass and mobility techniques for point detection
• compare active and passive techniques for standoff detection

INTENDED AUDIENCE
This course is intended for those interested in the design and development of chemical and biological sensors for applications ranging from military to industrial sensing. It is an overview course with a survey of a broad class of sensing techniques. Mathematical models for the various sensors will be presented and discussed; however, this course does not require an in-depth understanding of the mathematical principles to appreciate the technological benefits of the various approaches. Some background in electro-optical and infrared systems is helpful, but not required.

INSTRUCTOR
Patrick Gardner is a program manager for the Charles Stark Draper Laboratory. He received a B.S. from the University of Florida and a M.S. and Ph.D. in Electrical Engineering from the Air Force Institute of Technology. He is a retired Lt. Colonel, U.S. Air Force, with 25 years of active duty service. He was assigned to the U.S. Special Operations Command as a technical liaison officer for both the U.S. Air Force and the U.S. Dept. of Energy. Following active duty he served as Chief Scientist for General Dynamics ATP, Chemical & Biological Detection and Countermeasures. He is an adjunct professor for the electrical engineering department at Western Carolina University and regularly teaches professional short courses in chemical and biological detection for Georgia Tech University and others.

The information contained in this written material was developed from a compilation of sources available in the open literature. The information delivered in written and oral form does not represent the official position or interests of, or endorsement by any Federal or state departments or affiliated agencies. Specific vendor products are used as representative examples only and are not intended as critiques or endorsements of specific products and technologies.
Applications of Detection Theory

SC952

Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD

Thursday 8:30 am to 5:30 pm

The fundamental goal of this course is to enable you to assess and explain the performance of sensors, detectors, diagnostics, or any other type of system that is attempting to give, with some level of confidence, a determination of the presence or absence of a “target.” In this case the term “target” may be a wide variety of types (e.g. a biological pathogen or chemical agent; or a physical target of some sort; or even just some electronic signal). We will rigorously cover the theory and mathematics underlying the construction of the “Receiver Operating Characteristic” (ROC) curve, including dichotomous test histograms, false positives, false negatives, sensitivity, specificity, and total accuracy. In addition, we will discuss in depth the theory behind “Decision Tree Analysis” culminating with an in class exercise. Decision tree analysis allows one to “fuse together” multivariate signals (or results) in such a manner as to produce a more accurate outcome than would have been attained with any one signal alone. This course includes two major in class exercises: the first will involve constructing a ROC curve from real data with the associated analysis; the second will involve constructing a complete decision tree including the new (improved) ROC curve. The first exercise will be ~30min in length, and the second will be ~60min.

LEARNING OUTCOMES

This course will enable you to:
• define false positives, false negatives and dichotomous test
• define sensitivity, specificity, limit-of-detection, and response time
• comprehend and analyze a dose-response curve
• construct and analyze a Receiver Operating Characteristic (ROC) curve from raw data
• define Positive Predictive Value (PPV) and Negative Predictive Value (NPV)
• analyze statistical data and predict results
• describe the process and theory underlying decision tree analysis
• construct and analyze a decision tree using real data
• construct a “Spider Chart” from system-level attributes
• interpret sensor performance trade-offs using a ROC curve

INTENDED AUDIENCE

This course designed for scientists, engineers, and researchers that are involved in sensor design and development, particular from the standpoint of complex data analysis. Application areas for which Detection Theory is most relevant includes biological detection, medical diagnostics, radar, multi-spectral imaging, explosives detection and chemical agent detection. A working knowledge of basic freshman-level statistics is useful for this course.

INSTRUCTOR

John Carrano is President of Carrano Consulting. Previously, he was the Vice President, Research & Development, Corporate Executive Officer, and Chairman of the Scientific Advisory Board for Luminex Corporation, where he led the successful development of several major new products from early conception to market release and FDA clearance. Before joining Luminex, Dr. Carrano was a Program Manager at DARPA, where he created and led several major programs related to bio/chem sensing, hyperspectral imaging and laser systems. He retired from the military as a Lieutenant Colonel in June 2005 after over 24 years’ service; his decorations include the “Defense Superior Service Medal” from the Secretary of Defense. Dr. Carrano is a West Point graduate with a doctorate in Biochemistry.

COURSE PRICE INCLUDES a free PDF copy of the report, “Chemical and Biological Sensor Standards Study” (Principal author, Dr. John C. Carrano.)

Scanning Microscopy in Forensic Science

SC954

Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD

Monday 8:30 am to 5:30 pm

This one day short course will be devoted to the use of scanning microscopy copies including scanning electron microscopy (SEM), scanning optical profilometry, and energy dispersive x-ray (EDS) and x-ray fluorescence (XRF) spectrometry to forensic sample analyses including counter terrorism, explosives, pyrotechnics, counterfeit drugs and food and product tampering. The course is presented in four sections. Section one will provide the students with an understanding of the value and pitfalls of relying on instrument software in the examination of varying samples types and analysis conditions. Emphasis will be placed on issues of instrument quality assurance including calibration, operation and understanding your instrument’s data and compliance with certification organizations including ISO and ASCLD/LAB. Section two will be devoted to a presentation of sample handling and preparation as well as “unknown white powder” case analyses and other cases involving counterfeit drugs, food and product tampering. Section three will cover the issues of gunshot residue (GSR) analysis and more “unknown white powder” analyses related to pyrotechnic devices and flares as well as a presentation on improved acid/foil bombs. Section four will include additional approaches to the analyses of “unknown white powder” cases so common today, the capabilities of a forensic laboratory in supporting emergency responders, and a number of illustrative case histories. Additional topics may cover a Scientific Working Group on Gun Shot Residue (SWGGSR) update report and perspective on instant shooter GSR kits. This course will be jointly presented by four instructors, all recognized experts in their respective area of scanning microscopy and applications to forensic science.

LEARNING OUTCOMES

This course will enable you to:
• use a variety of techniques (many being very simple) to collect, isolate, and process suspect trace evidence particles and fibers for SEM/EDS analysis
• take back to your laboratory a number of effective tips and analytical approaches to small particle handling and analyses including the “unknown white powder”
• evaluate critical factors related to SEM/EDS calibration and how they relate to the accuracy of your measurements and subsequent analyses
• learn the state-of-the-art procedures in the analysis of GSR data by SEM/EDS
• learn the current guidelines in interpretation of GSR data
• relate and compare your personal analytical case work or quality control analyses to illustrated forensic cases and analytical approaches

INTENDED AUDIENCE

This course is directed at the laboratory analyst using scanning electron microscopy and energy dispersive x-ray spectrometry analyses as well as other types of scanning probe instrumentation in the analysis of trace evidence including unknown surfaces, individual particles, “unknown white powder” and gunshot residue. Individuals employed in other related fields including forensic laboratory accreditation, quality management, environmental sample and microchemical analyses will find this course beneficial. All analysts using SEM/EDS, regardless of their discipline, will find this course interesting and readily see how SEM/EDS analyses of forensic samples applies to many types of laboratory and environmental investigations.

INSTRUCTORS

S. Frank Platek is a Research Biologist in the Trace Examination Section of the U.S. FDA’s Forensic Chemistry Center. Prior to his 20 years with the FDA, he served 15 years as a research biologist with the National Institute for Occupation Safety and Health (NIOSH) specializing in SEM/TEM/EDS analysis of fine particles and fibers. Since 1993, he has been a member of the editorial review board of the Journal SCANNING and chairperson for the Scanning Microscopy in Forensic Science Session
and course for the International SCANNING meeting. He has served as a national touring speaker for the Microbeam Analysis Society and the Microscopy Society of America. He lectures in Forensic Science Applications of SEM at the Lehigh University Microscopy School and has taught SEM/EDS analysis at Northern Kentucky University for over 30 years. He is a member of the American Academy of Forensic Science, Mid-Western Association of Forensic Science, Microscopy Society of America, and Microscopy Society of the Ohio River Valley.

Michael Trimpe has worked at the Hamilton County Coroner’s Lab for 31 years. He is a Past President of the Midwestern Association of Forensic Scientists and received the Distinguished Scientist Award. He conducted the FBI GSR Symposium in 2005. He is the founder and chairman of the International Scientific Working Group for Gunshot Residue. He is a Fellow member of the American Academy of Forensic Sciences, and is the recipient of the Mary E. Cowen Award in the Criminalistics Section in 2010. His other scientific memberships include the European Network of Forensic Scientists, TWGFEX, and the International Association of Arson Investigators. Mr. Trimpe has taught the analysis of gunshot residue all over the country and has frequently been asked to speak at GSR Seminars all over the world.

Michael McVicar is an Assistant Section Head in the Chemistry Section of the Centre of Forensic Sciences (CFS) in Toronto, Canada. He has worked as a forensic chemist at the CFS for 24 years, reporting in true evidence casework involving glass, paint, polymers, fire debris, building materials, metals, and gunshot residue. He has applied scanning electron microscopy to trace evidence examination for over 20 years. He is a member of the Scientific Working Group for Gunshot Residue, is the Chemistry Section Chair of the Canadian Society of Forensic Science, a Member of the Technical Advisory Committee to ASCCL/DLAB, an invited speaker at the 2008 ENPSI Firearms/GSR meeting, an invited speaker at the 2006 Ontario Bar Association panel discussion on Gunshot Residue, and an invited speaker at the 2005 Osgoode Hall Law School Panel on “Best Practices for Collecting, Compiling and Communicating Expert Evidence.” He was a presenter on the Forensic Applications of SEM at the 2006, 2007, and 2008 Scanning Conferences.

Michael Postek is the Chief of the Mechanical Metrology Division within the new National Institute of Standards and Technology (NIST) Physical Measurement Laboratory. Dr. Postek was the Assistant to the NIST Director for Nanotechnology and is both a nationally and internationally recognized expert in nanometrology and scanning electron microscope (SEM) critical dimension (CD) metrology.

### Target Detection Algorithms for Hyperspectral Imagery

**SC995**

**Course level:** Introductory  
**CEU .65 Member $480 / Non-member $570 USD**  
**Thursday 8:30 am to 5:30 pm**

This course provides a broad introduction to the basic concept of automatic target and object detection and its applications in Hyperspectral Imagery (HSI). The primary goal of this course is to introduce the well-known target detection algorithms in hyperspectral imagery. Examples of the classical target detection techniques such as spectral matched filter, subspace matched filter, adaptive matched filter, orthogonal subspace, support vector machine (SVM) and machine learning are reviewed. Construction of invariance subspaces for target and background as well as the use of regularization techniques are presented. Standard atmospheric correction and compensation techniques are reviewed. Anomaly detection techniques for HSI and dual band FLIR imagery are also discussed. Applications of HSI for detection of mines, targets, humans, chemical plumes and anomalies are reviewed.

**LEARNING OUTCOMES**

This course will enable you to:

- describe the fundamental concepts of target detection algorithms as applied to HSI
- learn the procedure to use the generalized maximum likelihood ratio test to design spectral detectors
- describe the fundamental differences between different detection algorithms based on their model representations
- develop statistical models as well as subspace models for HSI data
- explain the difference between anomaly detection and classification
- distinguish between linear and nonlinear approaches (SVM and Kernel learning techniques)
- develop anomaly detection techniques for different environmental scenarios
- describe linear models and unmixing techniques for abundance measures
- plot ROC curves to evaluate the performance of the algorithms

**INTENDED AUDIENCE**

Scientists, engineers, technicians, or managers who wish to learn more about target detection in hyperspectral, multispectral or dual-band FLIR imagery. Undergraduate training in engineering or science is assumed.

**INSTRUCTOR**

**Nasser Nasrabadi** is a senior research scientist (ST) at US Army Research Laboratory (ARL). He is also an adjunct professor in the Electrical and Computer Engineering Department at the Johns Hopkins University. He is actively engaged in research in image processing, neural networks, automatic target recognition, and video compression and its transmission over high speed networks. He has published over 200 papers in journals and conference proceedings. He has been an associate editor for the IEEE Transactions on Image Processing, IEEE Transactions on Circuits and Systems for Video Technology and IEEE Transactions for Neural Networks. He is a Fellow of IEEE and SPIE.

### Lab-on-a-Chip Technology - Towards Portable Detection Systems

**SC1034**

**Course level:** Introductory  
**CEU .35 Member $275 / Non-member $325 USD**  
**Friday 8:30 am to 12:30 pm**

The miniaturization of analytical systems ultimately targets sample-in/result-out systems for the complete analysis of biological samples. Besides the enhanced performance of those systems - namely combining sample preparation, biological reaction, and the detection itself in one device - miniaturization enables the construction of portable systems for on-site analysis of suspicious samples. This course will provide a broad overview of the underlying technologies enabling the realization of a miniaturized integrated biological lab. It starts with the history over two decades of microfluidics and goes on to describe the fabrication technologies for miniaturized devices.

The main focus is the application of microfluidic components in biotechnology (e.g. separation techniques, PCR, Lab-on-a-Chip etc.) and chemistry (e.g. micro reactors, micro mixers etc.), leading finally to the challenges in their use for mobile detection of biological pathogens. Guidelines for the efficient development of microfluidic devices for mobile detection of biological agents will be presented, based on the microfluidic tool box concept. Finally, some hands-on tests with microfluidic devices will give the attendee an opportunity to get in touch with this novel technology.

**LEARNING OUTCOMES**

This course will enable you to:

- describe the basic physical and chemical principles of microfluidics
- identify the most interesting microfluidic components and their challenging applications in chemistry and life sciences
- review current products and development issues
- efficiently design microfluidic devices based on the microfluidic toolbox concept
- have microfluidic components fabricated for your own application
INTENDED AUDIENCE
This course will be of value for engineers and researchers from industry and academia, business developers, general managers with a need to learn about novel technologies, potential investors in microtechnology / microfluidics and anyone who is interested in the realization, application or commercialization of microfluidic components.

INSTRUCTOR
Claudia Gärtner
PhD studied chemistry and biology at the University of Düsseldorf, Germany. She obtained her PhD in biochemistry and became involved with microtechnologies at the Institute of Microtechnology Mainz (IMM). In 1999 she took over the position of the director of the newly founded Application Center for Microtechnology Jena, Germany (amt). She was involved in the founding of the biotechnology start-up “x-zyme” (2001) and the microfluidic company “microfluidic ChipShop” (2002). In 2002 she was nominated for the German Founders Prize and decorated with the Thuringian award for the best business concept for microfluidic ChipShop. In March 2006 Dr. Gaertner was named CEO for microfluidic ChipShop. She is involved in a wide variety of research projects in the field of lab-on-a-chip systems. Furthermore, she is leading several collaborative R&D aiming in the development of portable systems for the detection of B-agents.

Military Laser Safety

SC1035

Course level: Introductory

CEU .65 Member $480 / Non-member $570 USD
Wednesday 8:30 am to 5:30 pm

This course explains the basic hazards associated with the use of lasers commonly encountered by military and law enforcement personnel, with particular emphasis on operation in an outdoor environment. Both laser classification and certification of laser products will be covered. The Department of Defense has an exemption from the Food and Drug Administration that allows manufacturers to produce military specific laser devices not available to the general public. The rules for using the Department of Defense exemption or obtaining a variance to purchase these special purpose products are explained.

LEARNING OUTCOMES
This course will enable you to:
- describe how a laser could cause personal injury to either the eye or skin
- describe how laser exposure limits were developed
- describe visual interference levels
- describe nominal ocular hazard distance and nominal skin hazard distance
- list differences in laser classification according to the:
  - Food and Drug Administration (FDA),
  - International Electrotechnical Commission (IEC), and
  - American National Standards Institute (ANSI)
- describe eye protection specifications for glasses and filters, such as optical density and visual transmission
- classify military applications of lasers, such as range finding, designating targets, dazzling
- manufacture and sell a federally compliant laser product
- learn the origin of the military exemption - 76 EL-01 DOD
- know whether your product meets the criteria for a military specific product
- know what features are required for a military specific product
- purchase a military specific laser product from a manufacturer
- dispose of a military specific laser product that has been manufactured under 76 EL-01 DOD
- evaluate the variance process for making a product not fully in compliance with federal product performance standards
- request evaluation of a system designed for joint military service use

INTENDED AUDIENCE
Engineers, scientists, technicians and managers involved in the development of laser-based defense related products who need to understand the regulatory process for certifying these devices. Military and civilian personnel, involved in operations, range safety, and procurement, who want to understand the safety issues involved with the field use of lasers.

INSTRUCTOR
Wesley Marshall
has been involved with military laser safety for almost 40 years and has been involved with the development of laser safety standards and military products. He has evaluated hundreds of military specific laser systems and has published dozens of articles in peer reviewed technical journals. He has taught laser safety courses for the US Army, Occupational Safety and Health Administration, North Atlantic Treaty Organization, Laser Institute of America, and Rockwell Laser Industries. For over three years, he served as manager for the Army Institute of Health Laser/Optical Radiation Program (formerly known as CHPPM).

Testing and Evaluation of E-O Imaging Systems

SC067

Course level: Advanced

CEU .65 Member $560 / Non-member $650 USD
Thursday 8:30 am to 5:30 pm

This course describes all the quantitative and qualitative metrics that are used to characterize imaging system performance. While this course highlights thermal imaging systems, the concepts are generic and can be applied to all imaging systems (CCDs, intensified CCDs, CMOS, and near IR cameras). Data analysis techniques are independent of the sensor selected (i.e., wavelength independent). The difference lies in the input variable name (watts, lumens, or delta-T) and the output variable name (volts, lumens, or observer response). Slightly different test methodologies are used for visible and thermal imaging systems. Performance parameters discussed include resolution, responsivity, aperiodic transfer function, slit response function, random noise, uniformity, fixed pattern noise, modulation transfer function (MTF), contrast transfer function (CTF), minimum resolvable temperature (MRT), and the minimum resolvable contrast (MRC). The eye’s spatial and temporal integration allows perception of images whose signal-to-noise ratio (SNR) is less than unity. Since all imaging system spatially sample the scene, sampling artifacts occur in all imagery and therefore affects all measurements. Sampling can significantly affect MRT and MTF tests. Low SNR and sampling effects are interactively demonstrated. This course describes the most common testing techniques. Equally important is identifying those parameters that adversely affect results.

LEARNING OUTCOMES
This course will enable you to:
- write concise test procedures with unambiguous system specifications
- identify all appropriate test parameters
- describe the radiometric relationship between delta-T and spectral radiance
- differentiate between observer variability and system response during MRC and MRT testing
- describe the difference between the CTF and the MTF
- learn about the latest MTF measurement techniques
- discern the difference between poor system performance, peculiarities of the system under test, and measurement errors
- assess how sampling affects test results
- appreciate the benefits and short comings of fully automated testing
- identify parameters that can lead to poor results.
- learn about evolving standardized testing concepts

INTENDED AUDIENCE
The course is for managers, specification writers, and test engineers involved with all phases of imaging system characterization ranging from...
Courses

satisfying customer requirements to ensuring that specifications are unambiguous and testable.

INSTRUCTOR

Gerald Holst is an independent consultant for imaging system analysis and testing. He was a technical liaison to NATO, research scientist for DoD, and a member of the Lockheed-Martin senior technical staff. Dr. Holst has chaired the SPIE conference Infrared Imaging Systems: Design, Analysis, Modeling and Testing since 1989. He is author of over 30 journal articles and 6 books (published by SPIE and/or JCD Publishing). Dr. Holst is a member of OSA and is a SPIE Fellow.


Electro-Optical Imaging System Performance

SC154

Course level: Intermediate

CEU .65 Member $560 / Non-member $650 USD

Friday 8:30 am to 5:30 pm

While this course highlights thermal imaging systems, the concepts are generic and can be applied to all imaging systems (CCDs, intensified CCDs, CMOS, and near IR cameras). System analysis could be performed in the spatial domain. However, it is far easier to work in the frequency domain using MTFs. Subsystem MTFs are combined for overall system analysis. This is often called image chain modeling. Although the math is sometimes complex, the equations are graphed for easy understanding. With the Sept 2002 models (e.g., NVTherm), the minimum resolvable temperature (MRT) and minimum resolvable contrast (MRC) are coupled with the target signature and atmospheric transmittance to provide range performance predictions (target acquisition modeling). Three ranges are predicted: detection, recognition, and identification (often shorten to DRI). DRI ranges depend upon the subsystem MTFs, noise (primarily random and fixed pattern noise), the display, and the eye's response. The two-dimensional (fictitious) spatial frequency approach, three-dimensional noise model, and target discrimination metrics (Johnson's N50) are applied to performance predictions. The 2007 models (e.g., NVThermIP) employ contrast rather than MRT (MRC) for target acquisition and use V50 as a discrimination metric. Limitations and applications of NVTherm and NVThermIP are discussed with a brief demonstration of the models. Selection and optimization of a specific sensor depends upon a myriad of radiometric, spectral, and spatial parameters (e.g., target signature, atmospheric conditions, optics f-number, field-of-view, and detector responsivity). MTFs and their effect on imagery are interactively demonstrated. Spatial sampling is present in all cameras. Super-resolution reconstruction and microscan minimize sampling artifacts. Several optimization examples are discussed (case study examples).

LEARNING OUTCOMES

This course will enable you to:
• use the correct MTFs for image chain analysis
• describe the radiometric relationship between delta-T and spectral radiance
• compare the differences among scanning, staring, and microscan staring array performance
• recognize the limitations of back-of-the-envelope approximations such as resolution and sensitivity
• identify the subsystem (e.g., motion, optics, detector, electronics, and display) that limits performance
• appreciate limitations of range performance predictions (target acquisition predictions)
• determine if mid-wave (MWIR) or long-wave (LWIR) infrared is appropriate for your application
• appreciate the value of graphs rather than a table of numbers
• be conversant with the myriad of technological terms
• become a smart buyer, analyst, and/or user of imaging systems

INTENDED AUDIENCE

This course is intended for engineers, managers, and buyers who want to understand the wealth of information available from imaging system end-to-end analysis. It is helpful if the students are familiar with linear system theory (MTF analysis).

INSTRUCTOR

Gerald Holst is an independent consultant for imaging system analysis and testing. He was a technical liaison to NATO, research scientist for DoD, and a member of the Lockheed-Martin senior technical staff. Dr. Holst has chaired the SPIE conference Infrared Imaging Systems: Design, Analysis, Modeling and Testing since 1989. He is author of over 30 journal articles and 6 books (published by SPIE and/or JCD Publishing). Dr. Holst is a member of OSA and is a SPIE Fellow.


MTF in Optical and Electro-Optical Systems

SC157

Course level: Introductory

CEU .65 Member $520 / Non-member $610 USD

Wednesday 8:30 am to 5:30 pm

Modulation transfer function (MTF) is used to specify the image quality achieved by an imaging system. It is useful in analysis of situations where several independent subsystems are combined. This course provides a background in the application of MTF techniques to performance specification, estimation and characterization of optical and electro-optical systems.

LEARNING OUTCOMES

This course will enable you to:
• list the basic assumptions of linear systems theory, including the concept of spatial frequency
• identify relationship between impulse response, resolution, MTF, OTF, PTF, and CTF
• estimate the MTF for both diffraction-limited and aberration-limited systems
• explain the relationship between MTF, line response, and edge response functions
• identify MTF contributions from finite detector size, crosstalk, charge transfer inefficiency, and electronics
• summarize the effects of noise

INTENDED AUDIENCE

Engineers, scientists, and managers who need to understand and apply the basic concepts of MTF to specifying, estimating, or characterizing performance. Some prior background in Fourier concepts is helpful.

INSTRUCTOR

Alfred Ducharme is a professor of optics and electrical engineering in the College of Engineering and Computer Science at the University of Central Florida. He received a B.S. in Electrical Engineering from the University of Massachusetts/Lowell, and both a M.S. and Ph.D. in Electrical Engineering from the University of Central Florida/School of Optics (CREOL). Dr. Ducharme is the Program Coordinator for the 4-year undergraduate program in Photonics (BSEET-Photonics) offered by the Engineering Technology Department.

Introduction to Radiometry and Photometry

SC178

Course level: Introductory
CEU .35 Member $390 / Non-member $440 USD
Monday 8:30 am to 12:30 pm

In this half-day course the basic quantities of radiometry, their units, and their relationships to electro-magnetic field quantities are presented. Photometry, its units, and conversion factors to older units are also addressed. The course covers the fundamentals of blackbody radiation generation and transfer. The basic equations needed to set up and solve problems are discussed.

The course introduces radiometric and photometric sources, detectors of optical radiation, instrumentation, and calibration. The supplementary textbook, Introduction to Radiometry and Photometry by Ross McCluney, is provided with the course and offers more detail in detector optical/ electrical characterization, color theory, and optical properties of specific materials.

This course is an ideal lead-in to SC944 The Radiometry Case Files, which provides many applied examples of the concepts introduced here.

LEARNING OUTCOMES

This course will enable you to:
• learn the methodology used for quantifying and describing electromagnetic radiation from the extreme UV through the visible portions of the spectrum and into the far IR
• become conversant with the concepts, terminology, and units of both radiometry and photometry
• master key radiometric laws and approximations
• master the basics of photometry, the system of terminology and units used whenever the eye is the detector
• describe the characterization of optical properties of surfaces, materials, and objects
• gain insight into the design and calibration of radiometers and photometers

INTENDED AUDIENCE

This course is for engineers and scientists who deal with electromagnetic radiation who need to quantify this radiation using international standard units and terminology. The course is for teachers, students, and researchers interested in using proper methods, terminology, symbols, and units in their courses and their research work. It is also for practitioners solving problems in radiation transfer, and in measuring radiant and luminous flux in optical systems and in nature.

INSTRUCTOR

Barbara Grant is the co-author, with Jim Palmer, of The Art of Radiometry. For more than twenty years she has applied her engineering skills to solve problems in industries as diverse as aerospace and indoor tanning. A consultant in electro-optics, she received the M.S. degree in Optical Sciences from the University of Arizona and two NASA awards for her work on the GOES weather satellite imager and sounder. Her previous work for SPIE includes developing and chairing a special session on FLIR image analysis.

COURSE PRICE INCLUDES the text Introduction to Radiometry and Photometry (Artech House, 1994) by Ross McCluney.

Multispectral and Hyperspectral Image Sensors

SC194

Course level: Advanced
CEU .35 Member $275 / Non-member $325 USD
Wednesday 8:30 am to 12:30 pm

This course will describe the imaging capabilities and applications of the principal types of multispectral (MS) and hyperspectral (HS) sensors. The focus will be on sensors that work in the visible, near-infrared and shortwave-infrared spectral regimes, but the course will touch on longwave-infrared applications. A summary of the salient features of classical color imaging (human observation) will also be provided in an appendix.

LEARNING OUTCOMES

This course will enable you to:
• understand many of the applications and advantages of multispectral (MS) and hyperspectral (HS) imaging
• describe and categorize the properties of the principal MS / HS design types (multi-band scanner, starers with filter wheels, dispersive, wedge, and Fourier transform imagers with 2D arrays, etc.)
• list and define the relevant radiometric radiometric quantities, concepts and phenomenology
• understand the process of translating system requirements into sensor hardware constraints and specifications
• analyze signal-to-noise ratio, modulation-transfer-function, and spatial / spectral sampling for MS and HS sensors
• define, understand and apply the relevant noise-equivalent figures-of-merit (Noise-equivalent reflectance difference, Noise-equivalent temperature difference, Noise-equivalent spectral radiance, Noise-equivalent irradiance, etc.)
• describe the elements of the image chain from photons-in to bits-out (photon detection, video signal manipulation, analog processing, and digitization)
• list and review key imager subsystem technology elements (optical, focal plane, video electronics, and thermal)
• formulate a detailed end-to-end design example of a satellite imaging scanning HS sensor
• provide an appendix that summarizes color imaging principles and sensor associated elements for human observation applications (e.g. color television, still cameras, etc.)

INTENDED AUDIENCE

Engineers, scientists, and technical managers who are interested in understanding and applying multispectral and hyperspectral sensors in advanced military, civil, scientific and commercial applications.

INSTRUCTOR

Terrence Lomheim holds the position of Distinguished Engineer at The Aerospace Corp. He has 32 years of hardware and analysis experience in visible and infrared electro-optical systems, focal plane technology, and applied optics, and has authored and co-authored 53 publications in these technical areas. He is a Fellow of the SPIE.


Engineering Approach to Imaging System Design

SC713

Course level: Intermediate
CEU .5 Member $530 / Non-member $620 USD
Monday 8:30 am to 5:30 pm

This course discusses the three popular approaches to electro-optical imaging system design: spatial resolution, sensitivity (signal-to-noise ra-
and modulation transfer function (MTF) analysis. While often evaluated individually, all three must be considered to optimize system design. Usually, the dominant MTFs in machine vision devices are image motion (including random vibration of the sensor), optics (including aberrations), and the detector. For man-in-the-loop operation, the display and the eye are of concern and, in many situations, these limit the overall system performance.

Equally important, but often neglected is sampling; an inherent feature of all electronic imaging systems. Sampling, which creates blocky images and particularly bothersome with periodic targets such as test targets and bar codes. An engineering approach is taken. This course will provide numerous practical design examples (case studies) to illustrate the interplay between subsystem MTFs, resolution, sensitivity, and sampling.

**LEARNING OUTCOMES**

This course will enable you to:

- use approximations; often called ‘rules-of-thumb,’ or ‘back-of-the-envelope’ analysis
- identify the subsystem components that affect resolution and sensitivity
- determine if your system is resolution or sensitivity limited
- equivalently determine if your system is detector-limited or optics-limited
- determine which subsystem limits system performance and why
- understand sampling artifacts (Nyquist frequency limit, aliasing, Moiré patterns, and variations in object edge location and width)
- use MTFs, resolution, sensitivity, and sampling concepts for system optimization
- understand the trade-off between MTF and aliasing

**INTENDED AUDIENCE**

The course is for managers, system designers, test engineers, machine vision specialists, and camera users who want the best performance from their systems. It is helpful if the students are familiar with linear system theory (MTF analysis).

**INSTRUCTOR**

Gerald Holst is an independent consultant for imaging system analysis and testing. He was a technical liaison to NATO, research scientist for DoD, and a member of the Lockheed Martin senior technical staff. Dr. Holst has chaired the SPIE conference Infrared Imaging Systems: Design, Analysis, Modeling, and Testing since 1989. He is author of over 30 journal articles and 6 books (published by SPIE and/or JCD Publishing). Dr. Holst is a member of OSA and IEEE and is a SPIE Fellow.


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**Courses**

**Introduction to Optical and Infrared Sensor Systems**

SC789

**Course level: Introductory**

CEU .55 Member $480 / Non-member $570 USD

Friday 8:30 am to 5:30 pm

This course provides a broad introduction to optical (near UV-visible) and infrared sensor systems, with an emphasis on systems used in defense and security. Topics include both passive imagers and active laser radars (lidar/ladar). We begin with a discussion of radiometry and radiometric calculations to determine how much optical power is captured by a sensor system. We survey atmospheric propagation and phenomenology (absorption, emission, scattering, and turbulence) and explore how these issues affect sensor systems. Finally, we perform signal calculations that consider the source, the atmosphere, and the optical system and detector, to arrive at a signal-to-noise ratio for typical passive and active sensor systems. These principles of optical radiometry, atmospheric propagation, and optical detection are combined in examples of real sensors studied at the block-diagram level. Sensor system examples include passive infrared imagers, polarization imagers, and hyperspectral imaging spectrometers, and active laser radars (lidars or ladars) for sensing distributed or hard targets. The course organization is approximately one third on the radiometric analysis of sensor systems, one third on atmospheric phenomenology and detector parameters, and one third on example calculations and examination of sensor systems at the block-diagram level.

**LEARNING OUTCOMES**

This course will enable you to:

- understand and use radiometry for describing and calculating the flow of optical energy in an optical or infrared sensor system
- determine the radiometric throughput of sensor systems
- describe atmospheric phenomenology relevant to propagation of optical and infrared radiation
- explain how the atmosphere affects the performance of sensor systems
- use detector parameters with radiometric calculations to predict the signal received by passive and active sensors
- calculate signal-to-noise ratio for typical sensor systems
- understand real-world sensor systems at the block-diagram level
- explain the difference between and important concepts of passive reflection-based and emission-based imaging
- understand the basic operating principles of passive imagers and active laser radar (lidar/ladar) systems for distributed and solid target sensing

**INTENDED AUDIENCE**

Scientists, engineers, technicians, or managers who find themselves working on (or curious about) optical (uv-vis) and infrared sensor systems without formal training in this area. Undergraduate training in engineering or science is assumed.

**INSTRUCTOR**

Joseph Shaw has been developing optical remote sensing systems and using them in environmental and military sensing for two decades, first at NOAA and currently as professor of electrical engineering and physics at Montana State University. Recognition for his work in this field includes NOAA research awards, a Presidential Early Career Award for Scientists and Engineers, and the World Meteorological Organization’s Vaasala Prize. He earned a Ph.D. in Optical Sciences at the University of Arizona. Dr. Shaw is a Fellow of both the OSA and SPIE.

**Laser Range Gated Imaging Techniques**

SC838

**Course level: Intermediate**

CEU .35 Member $275 / Non-member $325 USD

Tuesday 1:30 to 5:30 pm

This course provides attendees with a detailed background in the benefits and applications of laser gated imaging, also known as Burst Illumination Radar (BIL). This technique covers the use of laser illumination in conjunction with focal plane arrays to improve the ability to detect and identify objects across a wide range of scenarios. The course concentrates on the components involved in such a system, the phenomena that are unique to laser illumination, and the performance one can expect from laser illuminated sensing. Practical examples to demonstrate the benefits and limitations of these systems will be covered. At the end of this course, you will be knowledgeable in the types of sources and sensors that can be used and the image processing that can be applied to optimize the system performance.

**LEARNING OUTCOMES**

This course will enable you to:

- compare the advantages and limitations of laser gated imaging systems
- describe various components within a laser gated imaging system
- compare the relative merits of gated detector technologies
- identify the parameters that influence system performance in resolution, SNR and laser characteristics
- analyze range performance predictions for different laser gated imaging systems
• judge atmospheric effects and their mitigation in laser illuminated imaging

INTENDED AUDIENCE
Engineers, scientists and managers who want to improve their understanding of the use of laser illumination for improved imaging techniques and the benefits of gated sensors. No background in laser gated imaging is assumed, although some familiarity with basic concepts of imaging systems will be advantageous.

INSTRUCTOR
Stuart Duncan is Chief Technical Officer with SELEX Sensors and Airborne Systems in the United Kingdom and has been involved in Electro Optic System Design and Integration for over 24 years. He is a Masters graduate from Imperial College, London.

The Radiometry Case Files

SC944
Course level: Introductory
CEU .35 Member $350 / Non-member $400 USD
Monday 1:30 to 5:30 pm

This course takes basic radiometric principles and applies them to calculate the amount of radiation reaching a system’s entrance aperture or focal plane for a variety of source-system combinations. It provides a wide array of examples from which solutions to related problems may be drawn. It encompasses the UV, visible, and infrared regions of the electromagnetic spectrum, and includes several cases taken directly from the instructor’s industrial experience.

Typical applications to be addressed include solar and overcast sky irradiance, IR system calibration, tanning lamp output, lighting illumination, sensor signals from specular and diffuse reflectors, star detection on orbit, solar simulators and integrating spheres.

LEARNING OUTCOMES
This course will enable you to:
• identify approaches to problem-solving based on source and geometry considerations
• calculate the amount of light received from single and multiple sources
• determine the effects of source material properties on calculations
• apply atmospheric and system spectral response characteristics to solution formulation
• operate a radiation slide rule
• qualify the limitations of your solution

INTENDED AUDIENCE
This class is designed for the practicing engineer or technologist who is expected to solve radiometric problems but is unsure what factors to identify in formulating a solution, or where to locate examples of similar problems. Though taught at an introductory level, the course assumes a basic familiarity with radiometric terminology.

INSTRUCTOR
Barbara Grant is the co-author, with Jim Palmer, of The Art of Radiometry. For more than twenty years she has applied her engineering skills to solve problems in industries as diverse as aerospace and indoor tanning. A consultant in electro-optics, she received the M.S. degree in Optical Sciences from the University of Arizona and two NASA awards for her work on the GOES weather satellite imager and sounder. Her previous work for SPIE includes developing and chairing a special session on FLIR image analysis.

COURSE PRICE INCLUDES the text The Art of Radiometry (SPIE Press, 2009) by James M. Palmer and Barbara G. Grant.

Super Resolution in Imaging Systems

SC946
Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Tuesday 8:30 to 5:30 pm

This course provides an introduction to the signal processing methods used to increase image resolution. Specifically, it provides attendees with the practical knowledge to estimate the benefits of using super resolution in an imaging system as well as the guidance to select the right super resolution method for a given application. The course is divided into three parts. In the first part, we describe the fundamental limits to resolution in an imaging system and establish the necessity of using signal processing as a mean to achieve super resolution. In the second part we focus on different super resolution techniques. Specifically, we cover defocus based techniques, zoom based techniques, photometry based techniques and edge enhancement based techniques.

In the third part of the course we provide some real life examples from various imaging fields to establish how the super resolution techniques work. The attendee will therefore benefit from a concise and realistic overview of current signal processing methods for super resolution, and thus be able to make the right decision when it comes to accessing the potential use of super resolution for a specific product development.

LEARNING OUTCOMES
This course will enable you to:
• explain the concept of point-spread function (PSF), modulation transfer function (MTF) and other key imaging functions along with the principles of image processing
• choose the right resolution enhancement method for your application from the range of available technologies in signal processing
• choose the right technology for the right performance/computation cost ratio
• compare the benefits and limitations of each resolution enhancement technology and describe the fundamentals of each method
• describe where signal processing for super resolution is applied today and where it may be applied tomorrow

INTENDED AUDIENCE
This course is intended for scientists, engineers, researchers, physicists, product development managers, directors of engineering, development engineers, or anyone who is interested in increasing resolution of imaging systems. The course helps the students to understand why, when and how to use signal processing to increase resolution in existing imaging systems and/or product lines and new product development programs, in order to decrease production costs, increase optical performance, or simply find new solutions to existing technological problems.

INSTRUCTORS
Saeed Bagheri (PhD) is with the IBM Thomas J. Watson Research Center in Yorktown Heights, NY. He received his B.S. from Sharif University of Technology in 2004. Later that year he joined Massachusetts Institute of Technology for his graduate studies where he graduated with two M.S. and a Ph.D. in 2007 majoring in Optics and Optimization. He has been with IBM since then. He has several refereed published articles as well as conference papers.

Bahram Javidi (PhD) is Board of Trustees Distinguished Professor at the University of Connecticut. He received his B.S. in Electrical Engineering from George Washington University in 1980 and his M.S. and Ph.D. in Electrical Engineering from the Pennsylvania State University in 1982 and 1986, respectively. Prof. Javidi is fellows of seven professional societies, including IEEE, OSA and SPIE. He has authored more than 620 book, chapter, refereed published articles, and conference papers. He was awarded the Alexander von Humboldt Prize for senior US scientists. He has received the SPIE Gabor Award and SPIE Technology Achievement award.
Cost-Conscious Tolerancing of Optical and IR Systems

SC947

Course level: Introductory
CEU .65 Member $480 / Non-member $570 USD
Wednesday 8:30 to 5:30 pm

The purpose of this course is to present concepts, tools, and methods that will help attendees determine optimal tolerances for opto-mechanical systems in optical applications. Detailed topics in the course apply to all volumes of systems being developed - from single systems to millions of units. The importance of tolerancing throughout the design process is discussed in detail, including determining robustness of the specification and design for manufacture and operation. The course also provides a background to effective tolerancing with discussions on variability and relevant applied statistics. A treatment of third-order aberrations is included, with emphasis on understanding their origins and how to influence cost and production yield by considering their impacts. Tolerance analysis and assignment with strong methodology and examples are discussed, including the development of a design trade for a simple IR system. References and examples are included to help researchers, designers, engineers, and technicians practically apply the concepts to plan, design, engineer, and build high-quality cost-competitive optical systems.

LEARNING OUTCOMES
This course will enable you to:
• identify key system requirements for tolerancing
• develop insight into cost and sensitivity factors early in the design process
• define variability and comprehend its impact on nominal systems
• utilize fundamental applied statistics in tolerancing
• construct tolerance analysis budgets
• perform detailed tolerance analysis
• summarize different design of experiment and statistical process control strategies

INTENDED AUDIENCE
This material is intended for managers, engineers, and technical staff involved in product design from concept through manufacturing.

INSTRUCTORS
Richard Youngworth Ph.D. is the Director of Optical Engineering at Light Capture, Inc., an optical and optomechanical design firm providing consulting, innovation incubation, and product development services. His industrial experience spans diverse topics including optical metrology, design, manufacturing, and analysis. In particular, Dr. Youngworth has spent significant time working on optical systems in the challenging transition from ideal design to successful volume manufacturing. He is widely considered an expert, due to his research, lectures, publications, and industrial work on the design, producibility, and tolerance analysis of optical components and systems. He has a B.S. in electrical engineering from the University of Colorado at Boulder and earned his Ph.D. in optics at the University of Rochester by researching tolerance analysis of optical systems.

James Contreras is a Principal Optical Engineer at Exotic Electro-Optics in Murrieta, CA, where he serves as the project lead for all optomechanical assembly projects. He has extensive experience in the design, analysis and fabrication of reflective and refractive optical systems for a variety of applications ranging from tactical military platforms to the James Webb Space Telescope. His primary expertise is in reflective and IR optical design, specializing in design for manufacturability. He is actively involved in teaching for SPIE and mentoring junior engineers. He was trained in Physics at Rensselaer Polytechnic Institute (B.S.) and the Georgia Institute of Technology (M.S.); the majority of his career has been in the defense and aerospace industry at companies such as Hughes Aircraft Company and Ball Aerospace Corp.

Infrared Imaging Radiometry

SC950

Course level: Advanced
CEU .65 Member $480 / Non-member $570 USD
Tuesday 8:30 am to 5:30 pm

This course will enable the user to understand how an infrared camera system can be calibrated to measure radiance and/or temperature and how the digital data is converted into radiometric data. The user will learn how to perform their own external, “by hand” calibrations on a science-grade infrared camera system using area or cavity blackbodies and an Excel spreadsheet provided by the instructor. The influences of lenses, ND and bandpass filters, windows, emissivity, reflections and atmospheric absorption on the system calibration will be covered. The instructor will use software to illustrate these concepts and will show how to measure emissivity using an infrared camera and how to predict system performance outside the calibration range.

LEARNING OUTCOMES
This course will enable you to:
• classify the measurement units of radiometry and thermography
• describe infrared camera transfer functions - electrical signal output versus radiance signal input
• determine which cameras, lenses and both cold and warm filters to select for your application
• assess effects of ND filters and bandpass filters on calibrations, and calculate which ND warm filter you need for a given temperature range of target
• perform radiometric calibration of camera systems using cavity and area blackbodies
• convert raw data to radiometric data, and convert radiometric data to temperatures
• measure target emissivity and calibrate emissivity into the system
• gauge and account for reflections and atmospheric effects on measurements

INTENDED AUDIENCE
This material is intended for engineers, scientists, graduate students and range technicians that are working with science-grade infrared cameras in the lab, on military test ranges, or similar situations.

INSTRUCTOR
Austin Richards is a senior research scientist at FLIR Commercial Vision Systems in Santa Barbara, and has specialized in scientific applications of infrared imaging technology for over 9 years. He holds a Ph.D. in astrophysics from UC Berkeley and is the author of the SPIE monograph Alien Vision: Exploring the Electromagnetic Spectrum with Imaging Technology.

Applications of Detection Theory

SC952

Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

The fundamental goal of this course is to enable you to assess and explain the performance of sensors, detectors, diagnostics, or any other type of system that is attempting to give, with some level of confidence, a determination of the presence or absence of a “target.” In this case the term “target” may be a wide variety of types (e.g. a biological pathogen or chemical agent; or a physical target of some sort; or even just some electronic signal). We will rigorously cover the theory and mathematics underlying the construction of the “Receiver Operating Characteristic” (ROC) curve, including dichotomous test histograms, false positives, false negatives, sensitivity, specificity, and total accuracy. In addition, we will discuss in depth the theory behind “Decision Tree Analysis” culminating with an in class exercise. Decision tree analysis allows one to “fuse together” multivariate signals (or results) in such a manner as to produce a more accurate outcome than would have been attained with any one signal alone. This course includes two major in class exercises:
the first will involve constructing a ROC curve from real data with the associated analysis; the second will involve constructing a complete decision tree including the new (improved) ROC curve. The first exercise will be ~30min in length, and the second will be ~60min.

LEARNING OUTCOMES
This course will enable you to:
• define false positives, false negatives and dichotomous test
• define sensitivity, specificity, limit-of-detection, and response time
• comprehend and analyze a dose-response curve
• construct and analyze a Receiver Operating Characteristic (ROC) curve from raw data
• define Positive Predictive Value (PPV) and Negative Predictive Value (NPV)
• analyze statistical data and predict results
• describe the process and theory underlying decision tree analysis
• construct and analyze a decision tree using real data
• construct a “Spider Chart” from system-level attributes
• interpret sensor performance trade-offs using a ROC curve

INTENDED AUDIENCE
This course designed for scientists, engineers, and researchers that are involved in sensor design and development, particular from the standpoint of complex data analysis. Application areas for which Detection Theory is most relevant includes biological detection, medical diagnostics, radar, multi-spectral imaging, explosives detection and chemical agent detection. A working knowledge of basic freshman-level statistics is useful for this course.

INSTRUCTOR
John Carrano is President of Carrano Consulting. Previously, he was the Vice President, Research & Development, Corporate Executive Officer, and Chairman of the Scientific Advisory Board for Luminex Corporation, where he led the successful development of several major new products from early conception to market release and FDA clearance. Before joining Luminex, Dr. Carrano was as a Program Manager at DARPA, where he created and led several major programs related to bio/chem sensing, hyperspectral imaging and laser systems. He retired from the military as a Lieutenant Colonel in June 2005 after over 24 years’ service; his decorations include the “Defense Superior Service Medal” from the Secretary of Defense. Dr. Carrano is a West Point graduate with a doctorate in Electrical Engineering from the University of Texas at Austin. He has co-authored over 50 scholarly publications and has 3 patents pending. He is the former DSS Symposium Chairman (2006-2007), and is an SPIE Fellow.

COURSE PRICE INCLUDES a free PDF copy of the report, “Chemical and Biological Sensor Standards Study” (Principal author, Dr. John C. Carrano.)

Target Detection Algorithms for Hyperspectral Imagery

SC995

Course level: Introductory
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

This course provides a broad introduction to the basic concept of automatic target and object detection and its applications in Hyperspectral Imagery (HSI). The primary goal of this course is to introduce the well known target detection algorithms in hyperspectral imagery. Examples of the classical target detection techniques such as spectral matched filter, subspace matched filter, adaptive matched filter, orthogonal subspace, support vector machine (SVM) and machine learning are reviewed. Construction of invariance subspaces for target and background as well as the use of regularization techniques are presented. Standard atmospheric correction and compensation techniques are reviewed. Anomaly detection techniques for HSI and dual band FLIR imagery are also discussed. Applications of HSI for detection of mines, targets, humans, chemical plumes and anomalies are reviewed.

LEARNING OUTCOMES
This course will enable you to:
• distinguish between linear and nonlinear approaches (SVM and Kernel learning techniques)
• develop anomaly detection techniques for different environmental scenarios
• describe linear models and unmixing techniques for abundance measures
• plot ROC curves to evaluate the performance of the algorithms

INTENDED AUDIENCE
Scientists, engineers, technicians, or managers who wish to learn more about target detection in hyperspectral, multispectral or dual-band FLIR imagery. Undergraduate training in engineering or science is assumed.

INSTRUCTOR
Nasser Nasrabadi is a senior research scientist (ST) at US Army Research Laboratory (ARL). He is also an adjunct professor in the Electrical and Computer Engineering Department at the Johns Hopkins University. He is actively engaged in research in image processing, neural networks, automatic target recognition, and video compression and its transmission over high speed networks. He has published over 200 papers in journals and conference proceedings. He has been an associate editor for the IEEE Transactions on Image Processing,IEEE Transactions on Circuits and Systems for Video Technology and IEEE Transactions for Neural Networks. He is a Fellow of IEEE and SPIE.

Introduction to Infrared and Ultraviolet Imaging Technology

SC1000

Course level: Introductory
CEU .35 Member $310 / Non-member $360 USD
Monday 1:30 to 5:30 pm

The words infrared and ultraviolet are coming into much more widespread use, as ideas about the technology penetrates the public’s awareness and becomes part of popular culture through TV and film. In industry and academia, applications for infrared and ultraviolet cameras are multiplying rapidly, because both of the continued reduction in system cost as the technology penetrates the commercial marketplace, and the forward march of technology. At the same time, there is a fairly limited body of information about applications for these cameras. This is because camera manufacturers tend focus on the products themselves, not applications, and because most textbooks on IR and UV technology are outdated and tend to emphasize the basics of radiometry and detection by single detectors, not imaging applications.

This course gives a non-technical overview of commercial infrared and ultraviolet camera systems, the “taxonomy” of infrared and ultraviolet wavebands, and the wide variety of applications for these wavebands. The course relies heavily on interesting imagery captured by the presenter over the last ten years and uses a SPIE monograph written by the author as a supplementary textbook.

LEARNING OUTCOMES
This course will enable you to:
• identify the different wavebands of the infrared and ultraviolet spectrum and describe their differences
• gain familiarity with the different types of cameras, sensors and optics used for imaging in the infrared and ultraviolet wavebands
• describe some of the key imaging applications for different wavebands of the infrared and ultraviolet
INTENDED AUDIENCE
The course is suitable both for technology professionals and non-technical persons who are new to infrared and ultraviolet imaging and want a very basic, qualitative overview of the fields with minimal mathematics. Little to no mathematical background is required.

INSTRUCTOR
Austin Richards is a senior research scientist at FLIR Systems in Santa Barbara, CA. He holds a PhD in Astrophysics from UC Berkeley, and has worked in the commercial infrared industry for over 10 years. He is also the CTO of Oculus Photonics, a small company devoted to near-ultraviolet imaging systems manufacturing, sales and support. Richards is the author of the SPIE monograph Alien Vision: Exploring the Electromagnetic Spectrum with Imaging Technology and an adjunct professor at the Brooks Institute of Photography in Santa Barbara.


Radar Micro-Doppler Signatures - Principles and Applications

SC1031
Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Monday 1:30 to 5:30 pm

This course explains basic principles and applications of the micro-Doppler signatures of radar targets. A micro-Doppler signature is a distinctive characteristic of the intricate frequency modulations generated from each component part of a target and is represented in the joint time and Doppler frequency domain. Micro-Doppler signatures provide unique target features that are complementary to those made available by existing methods.

The primary goals of the course are to describe the radar micro-Doppler effect, the mathematical and dynamic models of targets with various motions and the analysis of micro-Doppler signatures. The course will present current applications of radar micro-Doppler signature analysis to target detection, characterization, and classification. Radar data returned from rigid body motion and non-rigid body motion will be used in the presentation examples as well as simulations. Examples are shown from state-of-the-art radars in both anechoic chambers and realistic environments.

LEARNING OUTCOMES
This course will enable you to:
- describe the motion and Doppler effect resulting from rigid and non-rigid body motion
- determine the Micro-Doppler effect observed by a radar
- describe the radar EM scattering from a body with motion
- perform micro-Doppler processing, estimation, and analysis
- describe Mono-static, bi-static and multi-static micro-Doppler signatures
- evaluate the micro-Doppler of simple rigid body motions like a windmill or the rotating rotor blades of a helicopter
- interpret the micro-Doppler signature of human walking and various other human motions
- compare and classify the micro-Doppler signatures of humans, vehicles, and animals
- model the multi-static micro-Doppler signature
- perform micro-Doppler signature classification
- explain the role of angle of motion and lookdown angle on micro-Doppler

INTENDED AUDIENCE
Scientists, engineers, technicians, or managers who wish to understand the micro-Doppler effect in radar, the analysis of micro-Doppler signature of targets, and the applications of micro-Doppler signature for target recognition, identification, and classification. University professors, graduate students, and industry professionals are likely to benefit from this tutorial. Undergraduate training in engineering or science is assumed.

INSTRUCTORS
Victor Chen is internationally recognized for his work on micro-Doppler signatures and time-frequency analysis. He has published more than 130 papers and articles in books, chapters in books, journals and proceedings including the text “Time-Frequency Transforms for Radar Imaging and Signal Analysis” and the recent new text “Micro-Doppler Effect in Radar - Principles and Applications”. Dr. Chen is a Fellow of the IEEE.

David Tahmoush of the US Army Research Laboratory is contributing work on micro-Doppler signatures and classification analysis as well as example radar data. Dr. Tahmoush has published more than 30 papers and articles, and organizes the Workshop on Dismount Detection and Classification.

Optical Phased Array Technologies and Systems

SC1033
Course level: Introductory
CEU .5 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

This course is an introduction to Optical Phased Arrays and their applications in active electro-optical systems, including high energy laser systems, long range laser imaging and laser communications. The course will develop an understanding of high resolution imaging using multiple sub-apertures, high resolution laser beam projection using multiple sub-apertures, optical phased array beam steering, phased array beam propagation, adaptive optics as applied to phased arrays, and modeling of phased array systems.

Phased array component technologies to be covered will include fiber laser sources, high and low bandwidth imaging cameras, beam transport in fibers, non-mechanical beamsteering elements, and other system elements. Some systems issues discussed will include system efficiencies, optical isolation for transmitters and imagers, acquisition, tracking and pointing (ATP), phased array fire control, and system weight and volume estimation.

LEARNING OUTCOMES
This course will enable you to:
- design methods for phasing multiple optical sub-apertures to create a high resolution far field laser beam
- design wide angle, high efficiency, non-mechanical beam steering subsystems
- utilize methods for phasing multiple optical sub-apertures to create high resolution images
- describe optical phased array propagation for weapons, sensing, and communications
- design phased array adaptive optics
- utilize phased array HEL performance modeling, including isolation, steering, laser sources, ATP, and fire control
- design phased array subsystems including laser sources, high and low bandwidth imaging cameras, beam transport and phasing elements, and thermal and power management subsystems
- evaluate phased array systems and applications, including generic and mission specific system architectures

INTENDED AUDIENCE
Scientists, engineers, technicians, or managers who wish to learn more about how to design or use optical phased array based EO systems. Undergraduate training in engineering or science is assumed.

INSTRUCTORS
Kevin Probst is president and founder of The CORE Group, an independent defense consulting firm. He has spent over seven years in phased array research, modeling, analysis, and concept development. Previous experience includes the Airborne Laser Lab (ALL), Charles Stark Draper Labs, the AFRL Beam Control Division, the LEAPS Division, and the Strategic Defense Initiative Office (SDIO) where he served as the head of the ATP/FC division. Mr. Probst also served as Chief Scientist on the Zenith Star Space Based Laser program. For AFRL and DARPA he has worked...
Laser Sensors and Systems

Precision Stabilized Pointing and Tracking Systems

SC160

Course level: Intermediate

CEU .50 Member $480 / Non-member $570 USD

Tuesday 8:30 am to 5:30 pm

This course provides a practical description of the design, analysis, integration, and evaluation processes associated with development of precision stabilization, pointing and tracking systems. Major topics include stabilized platform technology, electro-mechanical systems configuration and analysis, and typical pointing and tracking system architectures.

LEARNING OUTCOMES

This course will enable you to:

• acquire the terminology of stabilization, pointing, and tracking systems and understand the common system architectures and operation
• define typical electro-mechanical configurations and key sub-systems and components used in precision stabilization and laser pointing systems
• describe the primary systems engineering tradeoffs and decisions that are required to configure and design stabilization, pointing and tracking systems
• distinguish the performance capabilities of specific design configurations

INTENDED AUDIENCE

This material is designed for engineers and managers responsible for design, analysis, development, or test of electro-optical stabilization, pointing and tracking systems or components. A minimum BS degree in an engineering discipline and familiarity with basic control systems is recommended.

INSTRUCTOR

James Hilkert is president of Alpha-Theta Technologies, an engineering consulting firm specializing in precision pointing, tracking and stabilization applications for clients such as Raytheon, General Dynamics, Northrop Grumman, DRS, Atlantic Positioning and the U.S. Navy. Prior to founding Alpha-Theta Technologies in 1994, he spent 20 years at Texas Instruments Defense Systems (now Raytheon) where he designed inertial tracking and pointing systems for a variety of military applications and later managed the Control Systems Technology Center. He received the Dr. Engineering degree from Southern Methodist University and MSME and BSME degrees from Mississippi State University, is a member of ASME, AIAA and SPIE, and lectures on control systems at The University of Texas at Dallas.
INTENDED AUDIENCE
This material is intended for engineers, scientists and students to further understand the practical applications and limitations of laser radar. Previous experience with radar and optical systems is recommended. Introduction to Laser Radar (SC167) or an equivalent course is a required prerequisite.

INSTRUCTOR
Gary Kamerman is the Chief Scientist of FastMetrix, Inc. and a Fellow of SPIE. He is the author of Laser Radar in the Infrared and Electro-Optical Handbook and the editor of the SPIE Milestone Series Laser Radar. He has designed, built and field tested laser radars for over 30 years and serves as a technical advisor to the Department of Defense, NASA and major international corporations.

Laser Beam Propagation for Applications in Laser Communications, Laser Radar, and Active Imaging
SC188
Course level: Intermediate
CEU .65 Member $610 / Non-member $700 USD
Thursday 8:30 am to 5:30 pm
This course describes beam wave propagation through optical turbulence. Satellite communication systems, laser radar, remote sensing, and adaptive optics are some of the applications affected by optical turbulence. Tractable analytic equations are provided for calculating Gaussian-beam wave statistical quantities affecting system performance. The mutual coherence function (MCF), mean intensity, degree of coherence, and intensity fluctuations (scintillation) are presented. Videos of actual experiments show how to gather data. Examples are presented using MATHEMATICA software programs. Copies of these programs are available in the text.

LEARNING OUTCOMES
This course will enable you to:
- calculate power budget for laser-based radar and communications systems
- calculate system reliability for laser radar and communication systems
- calculate backscatter effects from targets in monostatic and bistatic laser radar systems
- use MATHEMATICA programs to calculate statistical parameters for laser-based systems

INTENDED AUDIENCE
This course is intended for scientists, supervising and design engineers who are interested in understanding the propagation phenomena, which impose limitations on system performance, and in learning new approaches to improving system design.

INSTRUCTORS
Ronald Phillips is Director of the Florida Space Institute, Professor of Electrical and Computer Engineering, and an associate member of the School of Optics/CREOL at the University of Central Florida. He has worked in optical wave propagation for more than 25 years.
Larry Andrews is Professor of Mathematics and an associate member of School of Optics/CREOL at the University of Central Florida. He has worked in optical wave propagation for more than 20 years.


Laser Range Gated Imaging Techniques
SC838
Course level: Intermediate
CEU .35 Member $275 / Non-member $325 USD
Tuesday 1:30 to 5:30 pm
This course provides attendees with a detailed background in the benefits and applications of laser gated imaging, also known as Burst Illumination Radar (BIR). This technique covers the use of laser illumination in conjunction with focal plane arrays to improve the ability to detect and identify objects across a wide range of scenarios. The course concentrates on the components involved in such a system, the phenomena that are unique to laser illumination, and the performance one can expect from laser illuminated sensing. Practical examples to demonstrate the benefits and limitations of these systems will be covered. At the end of this course, you will be knowledgeable in the types of sources and sensors that can be used and the image processing that can be applied to optimize the system performance.

LEARNING OUTCOMES
This course will enable you to:
- compare the advantages and limitations of laser gated imaging systems
- describe various components within a laser gated imaging system
- compare the relative merits of gated detector technologies
- identify the parameters that influence system performance in resolution, SNR and laser characteristics
- analyze range performance predictions for different laser gated imaging systems
- judge atmospheric effects and their mitigation in laser illuminated imaging

INTENDED AUDIENCE
Engineers, scientists and managers who want to improve their understanding of the use of laser illumination for improved imaging techniques and the benefits of gated sensors. No background in laser gated imaging is assumed, although some familiarity with basic concepts of imaging systems will be advantageous.

INSTRUCTOR
Stuart Duncan is Chief Technical Officer with SELEX Sensors and Airborne Systems in the United Kingdom and has been involved in Electro Optic System Design and Integration for over 24 years. He is a Masters graduate from Imperial College, London.

Cost-Conscious Tolerancing of Optical and IR Systems
SC947
Course level: Introductory
CEU .65 Member $480 / Non-member $570 USD
Wednesday 8:30 to 5:30 pm
The purpose of this course is to present concepts, tools, and methods that will help attendees determine optimal tolerances for opto-mechanical systems in optical applications. Detailed topics in the course apply to all volumes of systems being developed - from single systems to millions of units. The importance of tolerancing throughout the design process is discussed in detail, including determining robustness of the specification and design for manufacture and operation. The course also provides a background to effective tolerancing with discussions on variability and relevant applied statistics. A treatment of third-order aberrations is included, with emphasis on understanding their origins and how to influence cost and production yield by considering their impacts. Tolerance analysis and assignment with strong methodology and examples are discussed, including the development of a design trade for a simple IR system. References and examples are included to help researchers, designers, engineers, and technicians practically apply the concepts to plan, design, engineer, and build high-quality cost-competitive optical systems.
LEARNING OUTCOMES
This course will enable you to:
- identify key system requirements for tolerancing
- develop insight into cost and sensitivity factors early in the design process
- define variability and comprehend its impact on nominal systems
- utilize fundamental applied statistics in tolerancing
- construct tolerance analysis budgets
- perform detailed tolerance analysis
- summarize different design of experiment and statistical process control strategies

INTENDED AUDIENCE
This material is intended for managers, engineers, and technical staff involved in product design from concept through manufacturing.

INSTRUCTORS
Richard Youngworth Ph.D. is the Director of Optical Engineering at Light Capture, Inc., an optical and optomechanical design firm providing consulting, innovation incubation, and product development services. His industrial experience spans diverse topics including optical metrology, design, manufacturing, and analysis. In particular, Dr. Youngworth has spent significant time working on optical systems in the challenging transition from ideal design to successful volume manufacturing. He is widely considered an expert, due to his research, lectures, publications, and industrial work on the design, productivity, and tolerance analysis of optical components and systems. He has a B.S. in electrical engineering from the University of Colorado at Boulder and earned his Ph.D. in optics at the University of Rochester by researching tolerance analysis of optical systems.

James Contreras is a Principal Optical Engineer at Exotic Electro-Optics in Murrieta, CA, where he serves as the project lead for all optomechanical assembly projects. He has extensive experience in the design, analysis and fabrication of reflective and refractive optical systems for a variety of applications ranging from tactical military platforms to the James Webb Space Telescope. His primary expertise is in reflective and IR optical design, specializing in design for manufacturability. He is actively involved in teaching for SPIE and mentoring junior engineers. He was trained in Physics at Rensselaer Polytechnic Institute (B.S.) and the Georgia Institute of Technology (M.S.); the majority of his career has been in the defense and aerospace industry at companies such as Hughes Aircraft Company and Ball Aerospace Corp.

Target Detection Algorithms for Hyperspectral Imagery

SC995
Course level: Introductory
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

This course provides a broad introduction to the basic concept of automatic target and object detection and its applications in Hyperspectral Imagery (HSI). The primary goal of this course is to introduce the well known target detection algorithms in hyperspectral imagery. Examples of the classical target detection techniques such as spectral matched filter, subspace matched filter, adaptive matched filter, orthogonal subspace, support vector machine (SVM) and machine learning are reviewed. Construction of invariance subspaces for target and background as well as the use of regularization techniques are presented. Standard atmospheric correction and compensation techniques are reviewed. Anomaly detection techniques for HSI and dual band FLIR imagery are also discussed. Applications of HSI for detection of mines, targets, humans, chemical plumes and anomalies are reviewed.

LEARNING OUTCOMES
This course will enable you to:
- describe the fundamental concepts of target detection algorithms as applied to HSI
- learn the procedure to use the generalized maximum likelihood ratio test to design spectral detectors
- describe the fundamental differences between different detection algorithms based on their model representations
- perform detailed anomaly detection analysis
- summarize different design of experiment and statistical process control strategies

INTENDED AUDIENCE
This material is intended for managers, engineers, and technical staff involved in product design from concept through manufacturing.

INSTRUCTOR
Richard Youngworth Ph.D. is the Director of Optical Engineering at Light Capture, Inc., an optical and optomechanical design firm providing consulting, innovation incubation, and product development services. His industrial experience spans diverse topics including optical metrology, design, manufacturing, and analysis. In particular, Dr. Youngworth has spent significant time working on optical systems in the challenging transition from ideal design to successful volume manufacturing. He is widely considered an expert, due to his research, lectures, publications, and industrial work on the design, productivity, and tolerance analysis of optical components and systems. He has a B.S. in electrical engineering from the University of Colorado at Boulder and earned his Ph.D. in optics at the University of Rochester by researching tolerance analysis of optical systems.

James Contreras is a Principal Optical Engineer at Exotic Electro-Optics in Murrieta, CA, where he serves as the project lead for all optomechanical assembly projects. He has extensive experience in the design, analysis and fabrication of reflective and refractive optical systems for a variety of applications ranging from tactical military platforms to the James Webb Space Telescope. His primary expertise is in reflective and IR optical design, specializing in design for manufacturability. He is actively involved in teaching for SPIE and mentoring junior engineers. He was trained in Physics at Rensselaer Polytechnic Institute (B.S.) and the Georgia Institute of Technology (M.S.); the majority of his career has been in the defense and aerospace industry at companies such as Hughes Aircraft Company and Ball Aerospace Corp.

High Power Laser Beam Quality

SC997
Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Wednesday 1:30 to 5:30 pm

This course covers definitions and applications of common measures of beam quality, including Brightness, Power-in-the-bucket, M², times diffraction limited, Strehl ratio, beam parameter product etc. Special emphasis will be given to choosing an appropriate beam quality metric, tracing the metric to the application of the laser system, and to various conceptual pitfalls which arise in this field. This course is especially applicable to novel lasers that may not have Gaussian modes, especially high energy lasers or unstable resonators. Material presented will come from general scientific literature as well as original work done by Dr. Sean Ross and Dr. William Latham, both from the Air Force Research Laboratory Directed Energy Directorate.

LEARNING OUTCOMES
This course will enable you to:
- convert between common measures of beam quality
- design an appropriate beam quality measure for your own laser application
- evaluate the suitability of commercial, black box beam quality analyzers for your application
- comprehend and take correct ISO 11146 M² measurements

INTENDED AUDIENCE
This course should benefit anyone with an interest in laser beam quality, including program managers, scientists and engineers who are not experts in the field.

INSTRUCTOR
T. Sean Ross has been with the Air Force Research Laboratory, Directed Energy Directorate, High Power Solid State Laser Branch since he received his PhD from the Center for Research and Education in Optics and Lasers (CREOL) in 1998. Research interests include nonlinear frequency conversion, high power solid state lasers, thermal management and laser beam quality. Beginning in 2000, frustration with commercial beam quality devices led to the work eventually presented in the Journal of Directed Energy, Vol. 2 No. 1 Summer 2006 “Appropriate Measures and Consistent Standard for High Energy Laser Beam Quality”. This paper and its conference version (presented at the 2005 DEPS Symposium) have received awards from the Directed Energy Professional Society and the Directed Energy Directorate.
Courses

Radar Micro-Doppler Signatures - Principles and Applications

SC1031
Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Monday 1:30 to 5:30 pm

This course explains basic principles and applications of the micro-Doppler signatures of radar targets. A micro-Doppler signature is a distinctive characteristic of the intricate frequency modulations generated from each component part of a target and is represented in the joint time and Doppler frequency domain. Micro-Doppler signatures provide unique target features that are complementary to those made available by existing methods.

The primary goals of the course are to describe the radar micro-Doppler effect, the mathematical and dynamic models of targets with various motions and the analysis of micro-Doppler signatures. The course will present current applications of radar micro-Doppler signature analysis to target detection, characterization, and classification. Radar data returned from rigid body motion and non-rigid body motion will be used in the presentation examples as well as simulations. Examples are shown from state-of-the-art radars in both anechoic chambers and realistic environments.

LEARNING OUTCOMES
This course will enable you to:
• describe the motion and Doppler effect resulting from rigid and non-rigid body motion
• determine the Micro-Doppler effect observed by a radar
• describe the radar EM scattering from a body with motion
• perform micro-Doppler processing, estimation, and analysis
• describe Mono-static, bi-static and multi-static micro-Doppler signatures
• evaluate the micro-Doppler of simple rigid body motions like a windmill or the rotating rotor blades of a helicopter
• interpret the micro-Doppler signature of human walking and various other various human motions
• compare and classify the micro-Doppler signatures of humans, vehicles, and animals
• model the multi-static micro-Doppler signature
• perform micro-Doppler signature classification
• explain the role of angle of motion and lockdown angle on micro-Doppler

INTENDED AUDIENCE
Scientists, engineers, technicians, or managers who wish to understand the micro-Doppler effect in radar, the analysis of micro-Doppler signature of targets, and the applications of micro-Doppler signature for target recognition, identification, and classification. University professors, graduate students, and industry professionals are likely to benefit from this tutorial. Undergraduate training in engineering or science is assumed.

INSTRUCTORS
Victor Chen is internationally recognized for his work on micro-Doppler signatures and time-frequency analysis. He has published more than 130 papers and articles in books, chapters in books, journals and proceedings including the text “Time-Frequency Transforms for Radar Imaging and Signal Analysis” and the recent new text “Micro-Doppler Effect in Radar - Principles and Applications”. Dr. Chen is a Fellow of the IEEE.

David Tahmoush of the US Army Research Laboratory is contributing work on micro-Doppler signatures and classification analysis as well as example radar data. Dr. Tahmoush has published more than 30 papers and articles, and organizes the Workshop on Dismount Detection and Classification.

Direct Detection Laser Radar Systems for Imaging Applications

SC1032
Course level: Advanced
CEU .5 Member $525 / Non-member $615 USD
Tuesday 8:30 am to 5:30 pm

As laser radar detection and ranging (LADAR) technologies continue to mature, more and more these systems are being applied to military, commercial and scientific applications. From simple time of flight range measurements to high resolution terrain mapping and 3-dimensional imaging, the utility of LADAR is being investigated across a wide range of applications.

In direct detection LADAR the measurements depend solely on the amplitude of the returned signal. This course is designed to teach students the basics of direct detection LADAR and how to transform customer or mission requirements into LADAR system performance specifications. Tools for modeling LADAR systems are introduced through the lecture material that allows quantification of important system performance metrics.

The course begins with the LADAR range equation and how it can be used to evaluate the impact factors such as atmospheric turbulence on LADAR performance. Students are introduced to direct detection LADAR modeling methods which help to explain how various LADAR subsystems affect LADAR range accuracy. A number of representative systems will be introduced as examples throughout the lectures. This course closely follows the included text Direct Detection LADAR Systems, SPIE Vol. TT85. The examples and problems presented in the book will be explored more fully during the course.

LEARNING OUTCOMES
This course will enable you to:
• compute the amount of laser power reflected from a target to a LADAR receiver
• calculate the expected signal to noise ratio obtained by a LADAR receiver
• determine the probability of detection and false alarm for different kinds of LADAR receivers
• explain the effects of atmospheric turbulence on LADAR system performance
• compare the performance of different algorithms for extracting range information from LADAR signals
• predict the effects of reflection from different surfaces on the performance of LADAR systems
• explain the functional differences between different types of 3-D LADAR systems

INTENDED AUDIENCE
Scientists, engineers, technicians, or managers who wish to learn more about how to evaluate the performance of direct detection laser radar systems and to quantify the impact that various effects have on LADAR performance as well as university professors who wish to offer courses in LADAR. Undergraduate training in engineering or science is assumed.

INSTRUCTORS
Richard Richmond worked in the Electro-Optics Technology Division of the Air Force Research Laboratory prior to his retirement in 2009. He was the Team Leader for Laser Radar Technology in the Multi-function Electro-optics Branch. Mr. Richmond has been the Project Engineer or Program Manager on numerous laser radar development and research efforts. Application areas of the various efforts have included both ground-based and airborne wind sensing, imaging and vibration sensing of hard targets, and remote chemical sensing. He has over 30 years experience in the development and application of laser based remote sensing, and is a Fellow of the MSS.
Stephen Cain is an associate professor of electrical engineering at the Air Force Institute of Technology. He received his B.S.E.E. from the University of Notre Dame in 1992, his M.S.E.E. from Michigan Technological University in 1994 and a Ph.D. in Electrical Engineering from the University of Dayton in 2001. He has served as a Captain in the United States Air Force, a Senior Scientist at Wyle Laboratories and a Senior Engineer at ITT/Aerospace and Communication Division. Dr. Cain has published a number of papers related to LADAR imaging and ranging and teaches a course on LADAR systems at AFIT.


Military Laser Safety

SC1035

Course level: Introductory
CEU .65 Member $480 / Non-member $570 USD
Wednesday 8:30 am to 5:30 pm

This course explains the basic hazards associated with the use of lasers commonly encountered by military and law enforcement personnel, with particular emphasis on operation in an outdoor environment. Both laser classification and certification of laser products will be covered. The Department of Defense has an exemption from the Food and Drug Administration that allows manufacturers to produce military specific laser devices not available to the general public. The rules for using the Department of Defense exemption or obtaining a variance to purchase these special purpose products are explained.

LEARNING OUTCOMES

This course will enable you to:
- describe how a laser could cause personal injury to either the eye or skin
- describe how laser exposure limits were developed
- describe visual interference levels
- describe nominal ocular hazard distance and nominal skin hazard distance
- list differences in laser classification according to the:
  - Food and Drug Administration (FDA),
  - International Electrotechnical Commission (IEC), and
  - American National Standards Institute (ANSI)
- describe eye protection specifications for glasses and filters, such as optical density and visual transmission
- classify military applications of lasers, such as range finding, designating targets, dazzling
- manufacture and sell a federally compliant laser product
- learn the origin of the military exemption - 76 EL-01 DOD
- know whether your product meets the criteria for a military specific product
- know what features are required for a military specific product
- purchase a military specific laser product from a manufacturer
- dispose of a military specific laser product that has been manufactured under 76 EL-01 DOD
- evaluate the variance process for making a product not fully in compliance with federal product performance standards
- request evaluation of a system designed for joint military service use

INTENDED AUDIENCE

Engineers, scientists, technicians and managers involved in the development of laser-based defense related products who need to understand the regulatory process for certifying these devices. Military and civilian personnel, involved in operations, range safety, and procurement, who want to understand the safety issues involved with the field use of lasers.
Diode Pumped Alkali Lasers

SC1036

Course level: Intermediate
CEU .35 Member $275 / Non-member $325 USD
Wednesday 1:30 to 5:30 pm

The quest for a high power, electrically driven laser with excellent thermal management, lightweight packaging, and high brightness for tactical military applications may be realized with the advent of the Diode Pumped Alkali Laser (DPAL). The concept of using a gas phase medium for the phasing of large diode arrays via a highly efficient, cyclical photon engine combines the best features of electrically driven lasers with the inherent thermal management advantages of gas lasers. Indeed, the DPAL concept has sparked great interest within the Directed Energy community resulting in a number of recent low power, highly efficient laser demonstrations. A modest national effort is underway to exploit this technology for military applications.

Early laser demonstrations of the Diode Pumped Alkali Laser achieved output powers of 1-3 W in both rubidium and cesium with slope efficiencies as high as 82%. More recently, cw output powers as high as 145 W with in-band slope efficiencies of 28% have been reported. The system is a three level laser pumped by diode bars on the D2 transition, exciting the first 2P3/2 state of the alkali atom. Collisional relaxation to the 2P1/2 state is accomplished with a spin orbit relaxing gas such as ethane or methane, while pressure broadening of the absorption line has routinely been accomplished with He. The excited alkali atom then lases on the D1 line back to the ground state. Terminating the laser level at the ground state requires the gain volume to be fully bleached before achieving an inversion between the 2P1/2 and 2S1/2 states, resulting in pump threshold values of ~1 kW/cm².

This course will develop the background spectroscopy and kinetics of the DPAL system, summarize recent laser demonstrations, discuss narrow banding of diode pump sources, develop the key performance and scaling equations, and outline several issues in the development of these devices.

LEARNING OUTCOMES
This course will enable you to:
• describe the history of optically pumped alkali laser development
• describe the operating principles of Diode Pumped Alkali Lasers
• calculate the DPAL absorption and stimulated emission cross-sections
• explain the hyperfine structure of the D1 and D2 lines of alkali atoms
• be familiar with narrow banding of diode pump sources
• use the DPAL kinetic database for laser modeling
• quantify the performance of DPAL devices including threshold, slope efficiency, and intensity scaling
• identify alternative schemes for infrared and visible optically pumped alkali lasers
• evaluate the prospects for scaling DPAL systems to high power
• assess the impact of atmospheric transmission at DPAL wavelengths

INTENDED AUDIENCE
Scientists and engineers with a basic understanding of lasers who seek understanding of the principles, performance limitations and applications of optically pumped alkali vapor lasers.

Senator Data and Information Exploitation

Fundamentals of Automatic Target Recognition

SC158

Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

This course is an overview of ATR systems, architecture, and components. Throughout the course various ATR sensors are discussed including: FLIR, SAR, LIDAR, and others. First, the course describes ATR system architecture. The course provides an overview of various ATR modules: preprocessing, image and signal enhancement, target detection, segmentation, feature extraction, and classifications. The course describes various features extraction techniques and classification methods, ranging from traditional statistical pattern recognition approaches to model-based techniques. The course presents an overview of advanced ATR concepts such as: multi-sensor systems, modeling and phenomenology, adaptive and neural net based methods, and other artificial intelligence techniques are described. Finally, we discuss evaluation techniques of ATR systems.

LEARNING OUTCOMES
This course will enable you to:
• have a broad understanding of ATR systems and technology
• have knowledge of current technology limitations
• describe key research areas and trends

INTENDED AUDIENCE
This course is for engineers entering the field or currently working in ATR, managers and marketing personnel, and program managers.

INSTRUCTOR
Firooz Sadjadi is a senior staff research scientist at Lockheed Martin Corporation where he is engaged in theoretical and experimental research related to Signal and Image Processing, automatic target recognition, target tracking and information fusion. He has served as the Chairman of the annual ATR Conference for the past 20 years. He has authored more than 150 publications, holds 11 US and International Patents and is the author of seven book chapters and editor of several books: Automatic Target Recognition Systems (2000), Sensor and Data Fusion (1996), Performance Evaluations of Signal and Image Processing Systems (1993), and The Physics of Automatic Target Recognition (2007). He received a BSEE from Purdue University in 1972, MSEE in 1974, and DEE in 1976 from the University of Southern California. He is a Fellow of SPIE.
Predicting Target Acquisition Performance of Electro-Optical Imagers

SC181

Course level: Advanced
CEU .65 Member $520 / Non-member $610 USD
Tuesday 8:30 am to 5:30 pm

This course describes how to predict and evaluate electro-optical (EO) imager performance. Metrics that quantify imager resolution are described. The detection, recognition, and identification tasks are discussed, and the meaning of acquisition probabilities is explained. The basic theory of operation of thermal imagers, image intensifiers, and video cameras is presented. This course describes how to quantify the resolution and noise characteristics of an EO imager. The theory and analysis of sampled imagers is emphasized. Image quality metrics are described, and the relationship between image quality and target acquisition performance is explained. The course provides a complete overview of how to analyze and evaluate the performance of EO imagers.

LEARNING OUTCOMES
This course will enable you to:
• describe what a target acquisition model does
• describe the operation of thermal sensors, video cameras and other EO imagers
• analyze the impact of sampling on targeting performance
• evaluate the targeting performance of an EO imager

INTENDED AUDIENCE
This course is intended for the design engineer or system analyst who is interested in quantifying the performance of EO imagers. Some background in linear systems analysis is helpful but not mandatory.

INSTRUCTOR
Richard Vollmerhausen recently retired from the Army’s Night Vision and Electronic Sensors Directorate. He is currently consulting. Mr. Vollmerhausen is the developer of the current generation of target acquisition models used by the Army.


Multispectral and Hyperspectral Image Sensors

SC194

Course level: Advanced
CEU .65 Member $275 / Non-member $325 USD
Wednesday 8:30 am to 12:30 pm

This course will describe the imaging capabilities and applications of the principal types of multispectral (MS) and hyperspectral (HS) sensors. The focus will be on sensors that work in the visible, near-infrared and shortwave-infrared spectral regimes, but the course will touch on longwave-infrared applications. A summary of the salient features of classical color imaging (human observation) will also be provided in an appendix.

LEARNING OUTCOMES
This course will enable you to:
• understand many of the applications and advantages of multispectral (MS) and hyperspectral (HS) imaging
• describe and categorize the properties of the principal MS / HS design types (multi-band scanner, staring with filter wheels, dispersive, wedge, and Fourier transform imagers with 2D arrays, etc.)
• list and define the relevant radiometric radiometric quantities, concepts and phenomenology
• understand the process of translating system requirements into sensor hardware constraints and specifications
• analyze signal-to-noise ratio, modulation-transfer-function, and spatial / spectral sampling for MS and HS sensors
• define, understand and apply the relevant noise-equivalent figures-of-merit (Noise-equivalent reflectance difference, Noise-equivalent temperature difference, Noise-equivalent spectral radiance, Noise-equivalent irradiance, etc.)
• describe the elements of the image chain from photons-in to bits-out (photon detection, video signal manipulation, analog processing, and digitization)
• list and review key imager subsystem technology elements (optical, focal plane, video electronics, and thermal)
• formulate a detailed end-to-end design example of a satellite imaging scanning HS sensor
• provide an appendix that summarizes color imaging principles and sensor associated elements for human observation applications (e.g. color television, still cameras, etc.)

INTENDED AUDIENCE
Engineers, scientists, and technical managers who are interested in understanding and applying multispectral and hyperspectral sensors in advanced military, civil, scientific and commercial applications.

INSTRUCTOR
Terrence Lomheim holds the position of Distinguished Engineer at The Aerospace Corp. He has 32 years of hardware and analysis experience in visible and infrared electro-optical systems, focal plane technology, and applied optics, and has authored and co-authored 53 publications in these technical areas. He is a Fellow of the SPIE.


Multisensor Data Fusion for Object Detection, Classification and Identification

SC994

Course level: Introductory
CEU .65 Member $550 / Non-member $640 USD
Tuesday 8:30 am to 5:30 pm

This course describes sensor and data fusion methods that improve the probability of correct target detection, classification, and identification. The methods allow the combining of information from collocated or dispersed sensors that utilize similar or different signature-generation phenomenologies. Examples provide insight as to how different phenomenology-based sensors enhance a data fusion system.

After introducing the JDL data fusion and resource management model, sensor and data fusion architectures are described in terms of sensor-level, central-level, and hybrid fusion, and pixel- / feature- / decision-level fusion. The data fusion algorithm taxonomies that follow provide an introduction to the descriptions of the algorithms and methods utilized for detection, classification, identification, and state estimation and tracking - the Level 1 fusion processes. These algorithms support the higher-level data fusion processes of situation and threat assessment.

Subsequent sections of the course more fully develop the Bayesian, Dempster-Shafer, and voting logic data fusion algorithms. Examples abound throughout the material to illustrate the major techniques being presented. The illustrative problems demonstrate that many of the data fusion methods can be applied to combine information from almost any grouping of sensors as long as they can supply the input data required by the fusion algorithm. Practitioners who want to identify the input quantities or parameters needed to implement data fusion will benefit from taking this course.

LEARNING OUTCOMES
This course will enable you to:
• identify multisensor data fusion principles, algorithms, and architectures for new and existing systems
• describe the advantages of multisensor data fusion for object discrimination and state estimation
• select appropriate sensors for specific sensor and data fusion applications
Courses

- identify potential algorithms for target detection, classification, identification, and tracking
- formulate sensor and data fusion approaches for many practical applications
- compare the detection and classification ability of many data fusion algorithms to those available without data fusion
- acquire the skills needed to develop and apply data fusion algorithms to more complex situations

INTENDED AUDIENCE
Engineers, scientists, managers, systems designers, military operations personnel, and other users of multisensor data fusion for target detection, classification, identification, and tracking of airborne, ground-based, and underwater targets will benefit from this course. Undergraduate training in engineering, science, or mathematics is assumed.

INSTRUCTOR
Lawrence Klein specializes in developing multiple sensor systems for tactical and reconnaissance military applications and homeland defense. His interests also include application of sensor and data fusion concepts to intelligent transportation systems. While at Hughes Aircraft Company, Dr. Klein developed missile deployment strategies and sensors for missile guidance. As Chief Scientist at Arotech ElectroSystems TAMS Division, he was responsible for programs that integrated active and passive millimeter-wave and infrared multispectral sensors in satellites and smart "fire-and-forget" weapons. At Honeywell, he designed passive millimeter-wave midcourse missile guidance systems and millimeter-wave sensors totrigger land mines. In addition to the course text, Dr. Klein has authored Millimeter-Wave and Infrared Multisensor Design and Signal Processing (Artech House, 1997), Sensor Technologies and Data Requirements for ITS (Artech House, 2001), and the Traffic Detector Handbook for the Federal Highway Administration (2006).


Target Detection Algorithms for Hyperspectral Imagery

SC995
Course level: Introductory
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

This course provides a broad introduction to the basic concept of automatic target and object detection and its applications in Hyperspectral Imagery (HSI). The primary goal of this course is to introduce the well known target detection algorithms in hyperspectral imagery. Examples of the classical target detection techniques such as spectral matched filter, subspace matched filter, adaptive matched filter, orthogonal subspace, support vector machine (SVM) and machine learning are reviewed. Construction of invariance subspaces for target and background as well as the use of regularization techniques are presented. Standard atmospheric correction and compensation techniques are reviewed. Anomaly detection techniques for HSI and dual band FLIR imagery are also discussed. Applications of HSI for detection of mines, targets, humans, chemical plumes and anomalies are reviewed.

LEARNING OUTCOMES
This course will enable you to:
- describe the fundamental concepts of target detection algorithms as applied to HSI
- learn the procedure to use the generalized maximum likelihood ratio test to design spectral detectors
- describe the fundamental differences between different detection algorithms based on their model representations
- develop statistical models as well as subspace models for HSI data
- explain the difference between anomaly detection and classification
- distinguish between linear and nonlinear approaches (SVM and Kernel learning techniques)
- develop anomaly detection techniques for different environmental scenarios
- describe linear models and unmixing techniques for abundance measures
- plot ROC curves to evaluate the performance of the algorithms

INTENDED AUDIENCE
Scientists, engineers, technicians, or managers who wish to learn more about target detection in hyperspectral, multispectral or dual-band FLIR imagery. Undergraduate training in engineering or science is assumed.

INSTRUCTOR
Nasser Nasrabadi is a senior research scientist (ST) at US Army Research Laboratory (ARL). He is also an adjunct professor in the Electrical and Computer Engineering Department at the Johns Hopkins University. He is actively engaged in research in image processing, neural networks, automatic target recognition, and video compression and its transmission over high speed networks. He has published over 200 papers in journals and conference proceedings. He has been an associate editor for the IEEE Transactions on Image Processing,IEEE Transactions on Circuits and Systems for Video Technology and IEEE Transactions for Neural Networks. He is a Fellow of IEEE and SPIE.

Radar Micro-Doppler Signatures - Principles and Applications

SC1031
Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Monday 1:30 to 5:30 pm

This course explains basic principles and applications of the micro-Doppler signatures of radar targets. A micro-Doppler signature is a distinctive characteristic of the intricate frequency modulations generated from each component part of a target and is represented in the joint time and Doppler frequency domain. Micro-Doppler signatures provide unique target features that are complementary to those made available by existing methods.

The primary goals of the course are to describe the radar micro-Doppler effect, the mathematical and dynamic models of targets with various motions and the analysis of micro-Doppler signatures. The course will present current applications of radar micro-Doppler signature analysis to target detection, characterization, and classification. Radar data returned from rigid body motion and non-rigid body motion will be used in the presentation examples as well as simulations. Examples are shown from state-of-the-art radars in both anechoic chambers and realistic environments.

LEARNING OUTCOMES
This course will enable you to:
- describe the motion and Doppler effect resulting from rigid and non-rigid body motion
- determine the Micro-Doppler effect observed by a radar
- describe the radar EM scattering from a body with motion
- perform micro-Doppler processing, estimation, and analysis
- describe Mono-static, bi-static and multi-static micro-Doppler signatures
- evaluate the micro-Doppler of simple rigid body motions like a windmill or the rotating rotor blades of a helicopter
- interpret the micro-Doppler signature of human walking and various other various human motions
- compare and classify the micro-Doppler signatures of humans, vehicles, and animals
- model the multi-static micro-Doppler signature
- perform micro-Doppler signature classification
- explain the role of angle of motion and lookdown angle on micro-Doppler
Military Laser Safety

**SC1035**

**Course level:** Introductory  
**CEU .65 Member $480 / Non-member $570 USD**  
**Wednesday 8:30 am to 5:30 pm**

This course explains the basic hazards associated with the use of lasers commonly encountered by military and law enforcement personnel, with particular emphasis on operation in an outdoor environment. Both laser classification and certification of laser products will be covered. This course explains the basic hazards associated with the use of lasers commonly encountered by military and law enforcement personnel, with particular emphasis on operation in an outdoor environment. Both laser classification and certification of laser products will be covered. The Department of Defense has an exemption from the Food and Drug Administration that allows manufacturers to produce military specific laser devices not available to the general public. The rules for using the Department of Defense exemption or obtaining a variance to purchase these special purpose products are explained.

**INSTRUCTORS**

**Victor Chen** is internationally recognized for his work on micro-Doppler signatures and time-frequency analysis. He has published more than 130 papers and articles in books, chapters in books, journals and proceedings including the text “Time-Frequency Transforms for Radar Imaging and Signal Analysis” and the recent new text “Micro-Doppler Effect in Radar - Principles and Applications”. Dr. Chen is a Fellow of the IEEE.

**David Tahmoush** of the US Army Research Laboratory is contributing work on micro-Doppler signatures and classification analysis as well as example radar data. Dr. Tahmoush has published more than 30 papers and articles, and organizes the Workshop on Dismount Detection and Classification.

**LEARNING OUTCOMES**

This course will enable you to:

- describe how a laser could cause personal injury to either the eye or skin  
- describe how laser exposure limits were developed  
- describe laser safety surveillance levels  
- describe nominal ocular hazard distance and nominal skin hazard distance  
- list differences in laser classification according to the:  
  - Food and Drug Administration (FDA),  
  - International Electrotechnical Commission (IEC), and  
  - American National Standards Institute (ANSI)  
- describe eye protection specifications for glasses and filters, such as optical density and visual transmission  
- classify military applications of lasers, such as range finding, designating targets, dazzling  
- manufacture and sell a federally compliant laser product  
- learn the origin of the military exemption - 76 EL-01 DOD  
- know whether your product meets the criteria for a military specific product  
- know what features are required for a military specific product  
- purchase a military specific laser product from a manufacturer  
- dispose of a military specific laser product that has been manufactured under 76 EL-01 DOD  
- evaluate the variance process for making a product not fully in compliance with federal product performance standards  
- request evaluation of a system designed for joint military service use

**INTENDED AUDIENCE**

Scientists, engineers, technicians, or managers who wish to understand the micro-Doppler effect in radar, the analysis of micro-Doppler signature of targets, and the applications of micro-Doppler signature for target recognition, identification, and classification. University professors, graduate students, and industry professionals are likely to benefit from this tutorial. Undergraduate training in engineering or science is assumed.

**Signal, Image, and Neural Net Processing**

Fundamentals of Electronic Image Processing

**SC066**

**Course level:** Introductory  
**CEU .65 Member $550 / Non-member $640 USD**  
**Monday 8:30 am to 5:30 pm**

Many disciplines of science and manufacturing acquire and evaluate images on a routine basis. Typically these images must be processed so that important features can be measured or identified. This short course introduces the fundamentals of electronic image processing to scientists and engineers who need to know how to manipulate images that have been acquired and stored within a digital computer.

**LEARNING OUTCOMES**

This course will enable you to:

- understand image storage, acquisition, and digitization  
- become familiar with image transforms such as Fourier, Hough, Walsh, Hadamar, Discrete Cosine, and Hotelling  
- understand the difference between the types of linear and non-linear filters and when to use each  
- learn the difference between types of noise in the degradation of an image  
- apply color image processing techniques to enhance key features in color and gray scale images  
- recognize image segmentation techniques and how they are used to extract objects from an image  
- understand software approaches to image processing  
- demonstrate how to use the UCFImage image processing software program included with the course.

**INSTRUCTOR**

**Wesley Marshall** has been involved with military laser safety for almost 40 years and has been involved with the development of laser safety standards and military products. He has evaluated hundreds of military specific laser systems and has published dozens of articles in peer reviewed technical journals. He has taught laser safety courses for the US Army, Occupational Safety and Health Administration, North Atlantic Treaty Organization, Laser Institute of America, and Rockwell Laser Industries. For over three years, he served as manager for the Army Institute of Health Laser/Optical Radiation Program (formerly known as CHPPM).

**Courses**
Super Resolution in Imaging Systems

SC946
Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Tuesday 8:30 to 5:30 pm

This course provides an introduction to the signal processing methods used to increase image resolution. Specifically, it provides attendees with the practical knowledge to estimate the benefits of using super resolution in an imaging system as well as the guidance to select the right super resolution method for a given application.

The course is divided into three parts. In the first part, we describe the fundamental limits to resolution in an imaging system and establish the necessity of using signal processing as a mean to achieve super resolution. In the second part we focus on different super resolution techniques. Specifically, we cover defocus based techniques, zoom based techniques, photometry based techniques and edge enhancement based techniques.

In the third part of the course we provide some real life examples from various imaging fields to establish how the super resolution techniques work. The attendee will therefore benefit from a concise and realistic overview of current signal processing methods for super resolution, and thus be able to make the right decision when it comes to accessing the potential use of super resolution for a specific product development.

LEARNING OUTCOMES

This course will enable you to:
- explain the concept of point-spread function (PSF), modulation transfer function (MTF) and other key imaging functions along with the principles of image processing
- choose the right resolution enhancement method for your application from the range of available technologies in signal processing
- choose the right technology for the right performance/computation cost ratio
- compare the benefits and limitations of each resolution enhancement technology and describe the fundamentals of each method
- describe where signal processing for super resolution is applied today and where it may be applied tomorrow

INTENDED AUDIENCE

This course is intended for scientists, engineers, researchers, physicists, product development managers, directors of engineering, development engineers, or anyone who is interested in increasing resolution of imaging systems. The course helps the students to understand why, when and how to use signal processing to increase resolution in existing imaging systems and/or product lines and new product development programs, in order to decrease production costs, increase optical performance, or simply find new solutions to existing technological problems.

INSTRUCTORS

Saeed Bagheri (PhD) is with the IBM Thomas J. Watson Research Center in Yorktown Heights, NY. He received his B.S. from Sharif University of Technology in 2004. Later that year he joined Massachusetts Institute of Technology for his graduate studies where he graduated with two M.S. and a Ph.D. in 2007 majoring in Optics and Optimization. He has been with IBM since then. He has several refereed published articles as well as conference papers.

Bahram Javidi (PhD) is Board of Trustees Distinguished Professor at the University of Connecticut. He received his B.S. in Electrical Engineering from George Washington University in 1980 and his M.S. and Ph.D. in Electrical Engineering from the Pennsylvania State University in 1982 and 1986, respectively. Prof. Javidi is fellows of seven professional societies, including IEEE, OSA and SPIE. He has authored more than 620 book, chapter, refereed published articles, and conference papers. He was awarded the Alexander von Humboldt Prize for senior US scientists. He has received the SPIE Gabor Award and SPIE Technology Achievement award.

Applications of Detection Theory

SC952
Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

The fundamental goal of this course is to enable you to assess and explain the performance of sensors, detectors, diagnostics, or any other type of system that is attempting to give, with some level of confidence, a determination of the presence or absence of a “target.” In this case the term “target” may be a wide variety of types (e.g. a biological pathogen or chemical agent; or a physical target of some sort; or even just some electronic signal). We will rigorously cover the theory and mathematics underlying the construction of the “Receiver Operating Characteristic” (ROC) curve, including dichotomous test histograms, false positives, false negatives, sensitivity, specificity and total accuracy. In addition, we will discuss in depth the theory behind “Decision Tree Analysis” culminating with an in class exercise. Decision tree analysis allows one to “fuse together” multivariate signals (or results) in such a manner as to produce a more accurate outcome than would have been attained with any one signal alone. This course includes two major in class exercises: the first will involve constructing a ROC curve from real data with the associated analysis; the second will involve constructing a complete decision tree including the new (improved) ROC curve. The first exercise will be ~30min in length, and the second will be ~60min.

LEARNING OUTCOMES

This course will enable you to:
- define false positives, false negatives and dichotomous test
- define sensitivity, specificity, limit-of-detection, and response time
- comprehend and analyze a dose-response curve
- construct and analyze a Receiver Operating Characteristic (ROC) curve from raw data
- define Positive Predictive Value (PPV) and Negative Predictive Value (NPV)
- analyze statistical data and predict results
- describe the process and theory underlying decision tree analysis
- construct and analyze a decision tree using real data
- construct a “Spider Chart” from system-level attributes
- interpret sensor performance trade-offs using a ROC curve

INTENDED AUDIENCE

This course is designed for scientists, engineers, and researchers that are involved in sensor design and development, particular from the standpoint of complex data analysis. Application areas for which Detection Theory is most relevant includes biological detection, medical diagnostics, radar, multi-spectral imaging, explosives detection and chemical agent detection. A working knowledge of basic freshman-level statistics is useful for this course.

INSTRUCTOR

John Carrano is President of Carrano Consulting. Previously, he was the Vice President, Research & Development, Corporate Executive Officer, and Chairman of the Scientific Advisory Board for Luminex Corporation, where he led the successful development of several major new products from early conception to market release and FDA clearance. Before joining Luminex, Dr. Carrano was as a Program Manager at DARPA, where he created and led several major programs related to bio/chem sensing, hyperspectral imaging and laser systems. He retired from the military as a Lieutenant Colonel in June 2005 after over 24 years’ service; his career included involvement in sensor design and development, particular from the standpoint of complex data analysis. Application areas for which Detection Theory is most relevant includes biological detection, medical diagnostics, radar, multi-spectral imaging, explosives detection and chemical agent detection. A working knowledge of basic freshman-level statistics is useful for this course.

COURSE PRICE INCLUDES a free PDF copy of the report, “Chemical and Biological Sensor Standards Study” (Principal author, Dr. John C. Carrano.)
Multisensor Data Fusion for Object Detection, Classification and Identification

SC994
Course level: Introductory
CEU .65 Member $550 / Non-member $640 USD
Tuesday 8:30 am to 5:30 pm

This course describes sensor and data fusion methods that improve the probability of correct target detection, classification, and identification. The methods allow the combining of information from colocated or dispersed sensors that utilize similar or different signature-generation phenomenologies. Examples provide insight as to how different phenomenology-based sensors enhance a data fusion system.

After introducing the JDL data fusion and resource management model, sensor and data fusion architectures are described in terms of sensor-level, central-level, and hybrid fusion, and pixel-, feature-, and decision-level fusion. The data fusion algorithm taxonomies that follow provide an introduction to the descriptions of the algorithms and methods utilized for detection, classification, identification, and state estimation and tracking - the Level 1 fusion processes. These algorithms support the higher-level data fusion processes of situation and threat assessment. Subsequent sections of the course more fully develop the Bayesian, Dempster-Shafer, and voting logic data fusion algorithms. Examples abound throughout the material to illustrate the major techniques being presented. The illustrative problems demonstrate that many of the data fusion methods can be applied to combine information from almost any grouping of sensors as long as they can supply the input data required by the fusion algorithm. Practitioners who want to identify the input quantities or parameters needed to implement data fusion will benefit from taking this course.

LEARNING OUTCOMES
This course will enable you to:
• identify potential algorithms for target detection, classification, and identification, and architectures for new and existing systems
• describe the advantages of multisensor data fusion for object discrimination and state estimation
• select appropriate sensors for specific sensor and data fusion applications
• identify potential algorithms for target detection, classification, identification, and tracking
• formulate sensor and data fusion approaches for many practical applications
• compare the detection and classification ability of many data fusion algorithms to those available without data fusion
• acquire the skills needed to develop and apply data fusion algorithms to more complex situations

INTENDED AUDIENCE
Engineers, scientists, managers, systems designers, military operations personnel, and other users of multisensor data fusion for target detection, classification, identification, and tracking of airborne, ground-based, and underwater targets will benefit from this course. Undergraduate training in engineering, science, or mathematics is assumed.

INSTRUCTOR
Lawrence Klein specializes in developing multiple sensor systems for tactical and reconnaissance military applications and homeland defense. His interests also include application of sensor and data fusion concepts to intelligent transportation systems. While at Hughes Aircraft Company, Dr. Klein developed missile deployment strategies and sensor for missile guidance. As Chief Scientist at Aerotech ElectroSystems TAMS Division, he was responsible for programs that integrated active and passive millimeter-wave and infrared multispectral sensors in satellites and smart “fire-and-forget” weapons. At Honeywell, he designed passive millimeter-wave mid course missile guidance systems and millimeter-wave sensors to trigger land mines. In addition to the course text, Dr. Klein has authored Millimeter-Wave and Infrared Multisensor Design and Signal Processing (Artech House, 1997), Sensor Technologies and Data Requirements for ITS (Artech House, 2001), and the Traffic Detector Handbook for the Federal Highway Administration (2006).

Target Detection Algorithms for Hyperspectral Imagery

SC995
Course level: Introductory
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

This course provides a broad introduction to the basic concept of automatic target and object detection and its applications in Hyperspectral Imagery (HSI). The primary goal of this course is to introduce the well known target detection algorithms in hyperspectral imagery. Examples of the classical target detection techniques such as spectral matched filter, subspace matched filter, adaptive matched filter, orthogonal subspace, support vector machine (SVM) and machine learning are reviewed. Construction of invariance subspaces for target and background as well as the use of regularization techniques are presented. Standard atmospheric correction and compensation techniques are reviewed. Anomaly detection techniques for HSI and dual band FLIR imagery are also discussed. Applications of HSI for detection of mines, targets, humans, chemical plumes and anomalies are reviewed.

LEARNING OUTCOMES
This course will enable you to:
• describe the fundamental concepts of target detection algorithms as applied to HSI
• learn the procedure to use the generalized maximum likelihood ratio test to design spectral detectors
• describe the fundamental differences between different detection algorithms based on their model representations
• develop statistical models as well as subspace models for HSI data
• explain the difference between anomaly detection and classification
• distinguish between linear and nonlinear approaches (SVM and Kernel learning techniques)
• develop anomaly detection techniques for different environmental scenarios
• describe linear models and unmixing techniques for abundance measures
• plot ROC curves to evaluate the performance of the algorithms

INTENDED AUDIENCE
Scientists, engineers, technicians, or managers who wish to learn more about target detection in hyperspectral, multispectral or dual-band FLIR imagery. Undergraduate training in engineering or science is assumed.

INSTRUCTOR
Nasser Nasrabadi is a senior research scientist (GT) at US Army Research Laboratory (ARL). He is also an adjunct professor in the Electrical and Computer Engineering Department at the Johns Hopkins University. He is actively engaged in research in image processing, neural networks, automatic target recognition, and video compression and its transmission over high speed networks. He has published over 200 papers in journals and conference proceedings. He has been an associate editor for the IEEE Transactions on Image Processing, IEEE Transactions on Circuits and Systems for Video Technology and IEEE Transactions for Neural Networks. He is a Fellow of IEEE and SPIE.
Courses

Sensing for Industry, Environment, and Health

Chemical & Biological Detection: Overview of Point and Standoff Sensing Technologies

SC719
Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Monday 8:30 am to 12:30 pm

This course introduces chemical and biological detection and identification techniques which are commonly utilized for military and civil applications. Remote and sampled detection, discrimination, and identification techniques are introduced with design parameters and performance models. A sampling of specific technology applications for chemical point, chemical standoff, biological point, and biological standoff sensing will be described. These technologies include Mass Spectrometry, Ion Mobility Spectrometry, Raman Spectroscopy, Fourier Transform Infrared Spectroscopy, Differential Absorption Lidar, Laser-Induced Fluorescence, Laser-Induced Breakdown Spectroscopy and others. The course will include a brief overview of chemical and biological agents and features which may be interrogated by detection systems.

LEARNING OUTCOMES
This course will enable you to:
• list and analyze chemical/biological detection and discrimination techniques
• describe the trade space for point and standoff detection
• estimate spatial, spectral, and temporal variations in chemical/biological media
• formulate fundamental design and performance equations for chemical/biological sensors
• compare mass and mobility techniques for point detection
• compare active and passive techniques for standoff detection

INTENDED AUDIENCE
This course is intended for those interested in the design and development of chemical and biological sensors for applications ranging from military to industrial sensing. It is an overview course with a survey of a broad class of sensing techniques. Mathematical models for the various sensors will be presented and discussed; however, this course does not require an in-depth understanding of the mathematical principles to appreciate the technological benefits of the various approaches. Some background in electro-optical and infrared systems is helpful, but not required.

INSTRUCTOR
Patrick Gardner is a program manager for the Charles Stark Draper Laboratory. He received a B.S. from the University of Florida and a M.S. and Ph.D. in Electrical Engineering from the Air Force Institute of Technology. He is a retired Lt. Colonel, U.S. Air Force, with 25 years of active-duty service. He was assigned to the U.S. Special Operations Command as a technical liaison officer for both the U.S. Air Force and the U.S. Dept. of Energy. Following active duty he served as Chief Scientist for General Dynamics ATP. Chemical & Biological Detection and Countermeasures. He is an adjunct professor for the electrical engineering department at Western Carolina University and regularly teaches professional short courses in chemical and biological detection for Georgia Tech University and others.

The information contained in this written material was developed from a compilation of sources available in the open literature. The information delivered in written and oral form does not represent the official position or interests of, or endorsement by any Federal or state departments or affiliated agencies. Specific vendor products are used as representative examples only and are not intended as critiques or endorsements of specific products and technologies.

Applications of Detection Theory

SC952
Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

The fundamental goal of this course is to enable you to assess and explain the performance of sensors, detectors, diagnostics, or any other type of system that is attempting to give, with some level of confidence, a determination of the presence or absence of a “target.” In this case the term “target” may be a wide variety of types (e.g. a biological pathogen or chemical agent; or a physical target of some sort; or even just some electronic signal). We will rigorously cover the theory and mathematics underlying the construction of the “Receiver Operating Characteristic” (ROC) curve, including dichotomous test histograms, false positives, false negatives, sensitivity, specificity, and total accuracy. In addition, we will discuss in depth the theory behind “Decision Tree Analysis” culminating with an in class exercise. Decision tree analysis allows one to “fuse together” multivariate signals (or results) in such a manner as to produce a more accurate outcome than would have been attained with any one signal alone. This course includes two major in class exercises: the first will involve constructing a ROC curve from real data with the associated analysis; the second will involve constructing a complete decision tree including the new (improved) ROC curve. The first exercise will be ~30min in length, and the second will be ~60min.

LEARNING OUTCOMES
This course will enable you to:
• define false positives, false negatives and dichotomous test
• define sensitivity, specificity, limit-of-detection, and response time
• comprehend and analyze a dose-response curve
• construct and analyze a Receiver Operating Characteristic (ROC) curve from raw data
• define Positive Predictive Value (PPV) and Negative Predictive Value (NPV)
• analyze statistical data and predict results
• describe the process and theory underlying decision tree analysis
• construct and analyze a decision tree using real data
• construct a “Spider Chart” from system-level attributes
• interpret sensor performance trade-offs using a ROC curve

INTENDED AUDIENCE
This course designed for scientists, engineers, and researchers that are involved in sensor design and development, particular from the standpoint of complex data analysis. Application areas for which Detection Theory is most relevant includes biological detection, medical diagnostics, radar, multi-spectral imaging, explosives detection and chemical agent detection. A working knowledge of basic freshman-level statistics is useful for this course.

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Target Detection Algorithms for Hyperspectral Imagery

SC995
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LEARNING OUTCOMES
This course will enable you to:
• describe the fundamental concepts of target detection algorithms as applied to HSI
• learn the procedure to use the generalized maximum likelihood ratio test to design spectral detectors
• describe the fundamental differences between different detection algorithms based on their model representations.
• develop statistical models as well as subspace models for HSI data
• explain the difference between anomaly detection and classification
• distinguish between linear and nonlinear approaches (SVM and Kernel learning techniques)
• develop anomaly detection techniques for different environmental scenarios
• describe linear models and unmixing techniques for abundance measures
• plot ROC curves to evaluate the performance of the algorithms

INTENDED AUDIENCE
Scientists, engineers, technicians, or managers who wish to learn more about target detection in hyperspectral, multispectral or dual-band FLIR imagery. Undergraduate training in engineering or science is assumed.

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Nasser Nasrabadi is a senior research scientist (ST) at US Army Research Laboratory (ARL). He is also an adjunct professor in the Electrical and Computer Engineering Department at the Johns Hopkins University. He is actively engaged in research in image processing, neural networks, automatic target recognition, and video compression and its transmission over high speed networks. He has published over 200 papers in journals and conference proceedings. He has been an associate editor for the IEEE Transactions on Image Processing, IEEE Transactions on Circuits and Systems for Video Technology and IEEE Transactions for Neural Networks. He is a Fellow of IEEE and SPIE.

Lab-on-a-Chip Technology - Towards Portable Detection Systems

SC1034
Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Friday 8:30 am to 12:30 pm

This course will enable you to:
• describe the basic physical and chemical principles of microfluidics
• identify the most interesting microfluidic components and their challenging applications in chemistry and life sciences
• review current products and development issues
• efficiently design microfluidic devices based on the microfluidic toolbox concept
• have microfluidic components fabricated for your own application

INTENDED AUDIENCE
This course will be of value for engineers and researchers from industry and academia, business developers, general managers with a need to learn about novel technologies, potential investors in microtechnology / microfluidics and anyone who is interested in the realization, application or commercialization of microfluidic components.

INSTRUCTOR
Claudia Gärtner PhD studied chemistry and biology at the University of Duesseldorf, Germany. She obtained her PhD in biochemistry and became involved with microtechnologies at the Institute of Microtechnology Mainz (IMM). In 1999 she took over the position of the director of the newly founded Application Center for Microtechnology Jena, Germany (amt). She was involved in the founding of the biotechnology start-up “x-zyme” (2001) and the microfluidic company “microfluidic ChipShop” (2002). In 2002 she was nominated for the German Founders Prize and decorated with the Thuringian award for the best business concept for microfluidic ChipShop. In March 2006 Dr. Gaertner was named CEO for microfluidic ChipShop. She is involved in a wide variety of research projects in the field of lab-on-a-chip systems. Furthermore, she is leading several collaborative R&D aiming in the development of portable systems for the detection of B-agents.

Courses

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Course fees
increase after
8 April 2011

TEL: +1 360 676 3290 · +1 888 504 8171 · customerservice@spie.org
The fundamental goal of this course is to enable you to assess and explain the performance of sensors, detectors, diagnostics, or any other type of system that is attempting to give, with some level of confidence, a determination of the presence or absence of a “target.” In this case the term “target” may be a wide variety of types (e.g. a biological pathogen or chemical agent; or a physical target of some sort; or even just some electronic signal). We will rigorously cover the theory and mathematics underlying the construction of the “Receiver Operating Characteristic” (ROC) curve, including dichotomous test histograms, false positives, false negatives, sensitivity, specificity, and total accuracy. In addition, we will discuss in depth the theory behind “Decision Tree Analysis” culminating with an in class exercise. Decision tree analysis allows one to “fuse together” multivariate signals (or results) in such a manner as to produce a more accurate outcome than would have been attained with any one signal alone. This course includes two major in class exercises: the first will involve constructing a ROC curve from real data with the associated analysis; the second will involve constructing a complete decision tree including the new (improved) ROC curve. The first exercise will be ~30min in length, and the second will be ~60min.

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- describe the process and theory underlying decision tree analysis
- construct and analyze a decision tree using real data
- construct a “Spider Chart” from system-level attributes
- interpret sensor performance trade-offs using a ROC curve

**INTENDED AUDIENCE**

This course designed for scientists, engineers, and researchers that are involved in sensor design and development, particular from the standpoint of complex data analysis. Application areas for which Detection Theory is most relevant includes biological detection, medical diagnostics, radar, multi-spectral imaging, explosives detection and chemical agent detection. A working knowledge of basic freshman-level statistics is useful for this course.

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**Multisensor Data Fusion for Object Detection, Classification and Identification**

**SC994**

**Course level: Introductory**

**CEU .65 Member $550 / Non-member $640 USD**

**Tuesday 8:30 am to 5:30 pm**

This course describes sensor and data fusion methods that improve the probability of correct target detection, classification, and identification. The methods allow the combining of information from collocated or dispersed sensors that utilize similar or different signature-generation phenomena. Examples provide insight as to how different phenomenology-based sensors enhance a data fusion system.

After introducing the JDL data fusion and resource management models, sensor and data fusion architectures are described in terms of sensor-based, central-level, and hybrid fusion, and pixel-, feature-, and decision-level fusion. The data fusion algorithm taxonomies that follow provide an introduction to the descriptions of the algorithms and methods utilized for detection, classification, identification, and state estimation and tracking - the Level 1 fusion processes. These algorithms support the higher-level data fusion processes of situation and threat assessment.

Subsequent sections of the course more fully develop the Bayesian, Dempster-Shafer, and voting logic data fusion algorithms. Examples abound throughout the material to illustrate the major techniques being presented. The illustrative problems demonstrate that many of the data fusion methods can be applied to combine information from almost any grouping of sensors as long as they can supply the input data required by the fusion algorithm. Practitioners who want to identify the input quantities or parameters needed to implement data fusion will benefit from taking this course.

**LEARNING OUTCOMES**

This course will enable you to:
- identify multisensor data fusion principles, algorithms, and architectures for new and existing systems
- describe the advantages of multisensor data fusion for object discrimination and state estimation
- select appropriate sensors for specific sensor and data fusion applications
- identify potential algorithms for target detection, classification, identification, and tracking
- formulate sensor and data fusion approaches for many practical applications
- compare the detection and classification ability of many data fusion algorithms to those available without data fusion
- acquire the skills needed to develop and apply data fusion algorithms to more complex situations

**INTENDED AUDIENCE**

Engineers, scientists, managers, systems designers, military operations personnel, and other users of multisensor data fusion for target detection, classification, identification, and tracking of airborne, ground-based, and underwater targets will benefit from this course. Undergraduate training in engineering, science, or mathematics is assumed.
INSTRUCTOR

Lawrence Klein specializes in developing multiple sensor systems for tactical and reconnaissance military applications and homeland defense. His interests also include application of sensor and data fusion concepts to intelligent transportation systems. While at Hughes Aircraft Company, Dr. Klein developed missile deployment strategies and sensors for missile guidance. As Chief Scientist at Aerojet ElectroSystems TAMS Division, he was responsible for programs that integrated active and passive millimeter-wave and infrared multispectral sensors in satellites and smart “fire-and-forget” weapons. At Honeywell, he designed passive millimeter-wave midcourse missile guidance systems and millimeter-wave sensors to trigger land mines. In addition to the course text, Dr. Klein has authored Millimeter-Wave and Infrared Multisensor Design and Signal Processing (Artech House, 1997), Sensor Technologies and Data Requirements for ITS (Artech House, 2001), and the Traffic Detector Handbook for the Federal Highway Administration (2006).


Innovative Defense and Security Applications for Displays

Head-Mounted Displays: Design and Applications

SC159

Course level: Introductory
CEU .65 Member $515 / Non-member $605 USD
Wednesday 8:30 am to 5:30 pm

Head-mounted displays (HMD) and the military counterpart helmet-mounted displays, are personal information-viewing devices that can provide information in a way that no other display can because the information is always available for viewing. By making the imagery reactive to head and body movements we replicate the way humans view, navigate and explore the world. This unique capability lends itself to applications such as Virtual Reality for creating artificial environments, medical visualization as an aid in surgical procedures, military vehicles for viewing sensor imagery, aircraft simulation and training, and for fixed and rotary wing avionics display applications.

This course covers design fundamentals for head-mounted displays from the user's point of view starting with the basics of human perception, head and neck biomechanics, image sources, optical design and head mounting. We will also discuss the impact of user task requirements and applications on various HMD parameters, as well as a detailed discussion of HMD optical designs (pupil and non-pupil forming, see-through and non-see-through, monocular, biocular and binocular, exit pupil and eye relief).

From there we will delve into various image source technologies, discussing advantages and disadvantages of the various approaches and methods for producing color imagery, with their implications for use in the near-eye presentation of imagery. We will also discuss head/neck anatomy and biomechanics and the implications of HMD weight and center of gravity on crash and ejection safety. Also presented will be the physics of human vision as it relates to display design. We will also dedicate time to human factors aspects of HMDs such as center of gravity on crash and ejection safety. Also presented will be the implications of HMD weight and center of gravity on crash and ejection safety. Also presented will be the anatomy and biomechanics and the implications of HMD weight and center of gravity on crash and ejection safety. Also presented will be the implications of HMD weight and center of gravity on crash and ejection safety.

LEARNING OUTCOMES
This course will enable you to:
- define basic components and attributes of head-mounted displays and visually coupled systems
- describe important features and enabling technologies of an HMD and their impact on user performance and acceptance
- identify key user-oriented performance requirements and link their impact on HMD design parameters
- list basic features of the human visual system and biomechanical attributes of the head and neck and the guidelines to follow to prevent fatigue or strain
- identify key tradeoffs for monocular, binocular and biocular systems
- classify current image source technologies and their methods for producing color imagery
- describe methods of producing wide field of view, high resolution HMDs
- evaluate tradeoffs for critical display performance parameters

INTENDED AUDIENCE

This course is intended for managers, engineers and scientists involved in the procurement, evaluation, specification or design of HMDs for air or ground-based applications.

INSTRUCTORS

Lawrence Klein is Manager of Research and Technology at Rockwell Collins Optronics, in Carlsbad, California. He has extensive experience in optical and displays engineering, and is an expert in display design for head-mounted systems, aviation life-support, and user interface. He has authored over 35 technical papers and holds four patents in HMD design. He was recently IPT lead for the US Army’s Future Force Warrior and Air Warrior Integrated Headgear Product teams.

Michael Browne is the Vice President of Product Development at SA Photonics in San Francisco, California. He has a Ph.D. in Optical Engineering from the University of Arizona’s Optical Sciences Center. Mike has been involved in the development, test, and measurement of head mounted display systems since 1991. At Kaiser Electronics, Mike led the design of numerous head mounted display and rear-projection display systems, including those for the F-35 Joint Strike Fighter. Mike leads SA Photonics’ efforts in the design and development of person-mounted information systems, including body-worn electronics, head-mounted displays and night vision systems. Mike’s current research includes investigations into binocular rivalry in head mounted displays, simulator sickness prediction and prevention, and the design of wide field of view night vision systems.


Unmanned, Robotic, and Layered Systems

Incorporating GPS Technology into Commercial and Military Applications

SC549

Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Wednesday 1:30 to 5:30 pm

The Global Positioning System (GPS) has evolved from its military roots to an ideal example of dual-use technology. This course briefly describes the GPS theory and the state of art in GPS technology. The issues involved in incorporating GPS in various commercial and military applications will be highlighted and various technologies will be illustrated using case studies.

LEARNING OUTCOMES
This course will enable you to:
- understand the basic principles and capabilities of GPS
- understand the GPS technology available for commercial and military applications
- be exposed to the latest advances in GPS
- identify the conditions under which certain levels of performance are achievable with current hardware and software
Courses

• identify commercially available GPS chipsets and modules
• evaluate concepts of GPS integration with other sensors
• evaluate the suitability of GPS as an alternative means of positioning, attitude, and time determination

INTENDED AUDIENCE
This course is for engineers, systems designers, and managers who wish to understand the recent innovations in GPS technology and how to design systems that take advantage of these capabilities for commercial and military applications. Some familiarity with basic GPS operation is helpful. Examples will be presented from airborne systems for remote sensing and other applications.

INSTRUCTOR
Zhen Zhu received a Ph. D. in Electrical Engineering from Ohio University, Athens, Ohio. Currently he is a Senior Research Engineer with the Ohio University Avionics Engineering Center and an adjunct assistant professor with the School of Electrical Engineering and Computer Science. He is a member of ION, IEEE and Sigma Xi. His research interests include GPS and augmentation systems, software radio technology, GPS interference and multipath, computer vision and laser based navigation, automatic navigation and guidance. He has also been involved in research of artificial intelligence, neural networks and machine learning.

Applications of Detection Theory
SC952
Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

The fundamental goal of this course is to enable you to assess and explain the performance of sensors, detectors, diagnostics, or any other type of system that is attempting to give, with some level of confidence, a determination of the presence or absence of a “target.” In this case the term “target” may be a wide variety of types (e.g. a biological pathogen or chemical agent; or a physical target of some sort; or even just some electronic signal). We will rigorously cover the theory and mathematics underlying the construction of the “Receiver Operating Characteristic” (ROC) curve, including dichotomous test histograms, false positives, false negatives, sensitivity, specificity, and total accuracy. In addition, we will discuss in depth the theory behind “Decision Tree Analysis” culminating with an in class exercise. Decision tree analysis allows one to “fuse together” multivariate signals (or results) in such a manner as to produce a more accurate outcome than would have been attained with any one signal alone. This course includes two major in class exercises: the first will involve constructing a ROC curve from real data with the associated analysis; the second will involve constructing a complete decision tree including the new (improved) ROC curve. The first exercise will be ~30min in length, and the second will be ~60min.

LEARNING OUTCOMES
This course will enable you to:
• define false positives, false negatives and dichotomous test
• define sensitivity, specificity, limit-of-detection, and response time
• comprehend and analyze a dose-response curve
• construct and analyze a Receiver Operating Characteristic (ROC) curve from raw data
• define Positive Predictive Value (PPV) and Negative Predictive Value (NPV)
• analyze statistical data and predict results
• describe the process and theory underlying decision tree analysis
• construct and analyze a decision tree using real data
• construct a “Spider Chart” from system-level attributes
• interpret sensor performance trade-offs using a ROC curve

INTENDED AUDIENCE
This course designed for scientists, engineers, and researchers that are involved in sensor design and development, particular from the standpoint of complex data analysis. Application areas for which Detection Theory is most relevant includes biological detection, medical diagnostics, radar, multi-spectral imaging, explosives detection and chemical agent detection. A working knowledge of basic freshman-level statistics is useful for this course.

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Introduction to GPS Receivers
SC996
Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Wednesday 8:30 am to 12:30 pm

This course is an introduction to the principles of the Global Positioning System (GPS) and GPS receivers. It includes a brief introduction to GPS and other related Global Satellite Navigation systems and the history of GPS receiver development. The architecture of a typical commercial GPS receiver will be explained, followed by a more detailed comparison of different types of receivers with respect to their performance, cost and special features. The newest technologies in GPS receivers will also be presented. The course will help to answer questions such as “Can I benefit from using GPS?”, or “How do I choose the right GPS receiver for my application?”

LEARNING OUTCOMES
This course will enable you to:
• describe the principles of satellite navigation
• learn how GPS receivers work
• decide when and how GPS would help in your application
• compare the cost/benefit of different types of receivers
• choose the right receiver for the application
• combine GPS with other sensors
• know what to expect from future GPS receivers

INTENDED AUDIENCE
Current and potential users of GPS who are using, or may need GPS receivers for:
• Position calculation and surveying
• Surveillance and target tracking
• Precise time keeping
• Airborne, land-based and marine-based vehicle navigation
• Location, installation, initialization and calibration of other sensors

INSTRUCTOR
Zhen Zhu received a Ph. D. in Electrical Engineering from Ohio University, Athens, Ohio. Currently he is a Senior Research Engineer with the Ohio University Avionics Engineering Center and an adjunct assistant professor with the School of Electrical Engineering and Computer Science. He is a member of ION, IEEE and Sigma Xi. His research interests include GPS and augmentation systems, software radio technology, GPS interference and multipath, computer vision and laser based navigation, automatic navigation and guidance. He has also been involved in research of artificial intelligence, neural networks and machine learning.
Emerging Technologies
Lab-on-a-Chip Technology - Towards Portable Detection Systems

SC1034
Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Friday 8:30 am to 12:30 pm

The miniaturization of analytical systems ultimately targets sample-in/ result-out systems for the complete analysis of biological samples. Besides the enhanced performance of those systems - namely combining sample preparation, biological reaction, and the detection itself in one device - miniaturization enables the construction of portable systems for on-site analysis of suspicious samples. This course will provide a broad overview of the underlying technologies enabling the realization of a miniaturized integrated biological lab. It starts with the history over two decades of microfluidics and goes on to describe the fabrication technologies for miniaturized devices.

The main focus is the application of microfluidic components in biotechnology (e.g. separation techniques, PCR, Lab-on-a-Chip etc.) and chemistry (e.g. micro reactors, micro mixers etc.), leading finally to the challenges in their use for mobile detection of biological pathogens. Guidelines for the efficient development of microfluidic devices for mobile detection of biological agents will be presented, based on the microfluidic toolbox concept. Finally, some hands-on tests with microfluidic devices will give the attendee an opportunity to get in touch with this novel technology.

LEARNING OUTCOMES
This course will enable you to:
• describe the basic physical and chemical principles of microfluidics
• identify the most interesting microfluidic components and their challenging applications in chemistry and life sciences
• review current products and development issues
• efficiently design microfluidic devices based on the microfluidic toolbox concept
• have microfluidic components fabricated for your own application

INTENDED AUDIENCE
This course will be of value for engineers and researchers from industry and academia, business developers, general managers with a need to learn about novel technologies, potential investors in microtechnology / microfluidics and anyone who is interested in the realization, application or commercialization of microfluidic components.

INSTRUCTOR
Claudia Gärtner
PhD studied chemistry and biology at the University of Dusseldorf, Germany. She obtained her PhD in biochemistry and became involved with microtechnologies at the Institute of Microtechnology Mainz (IMM). In 1999 she took over the position of the director of the newly founded Application Center for Microtechnology Jena, Germany (amt). She was involved in the founding of the biotechnology start-up “x-zyme” (2001) and the microfluidic company “microfluidic ChipShop” (2002). In 2002 she was nominated for the German Founders Prize and decorated with the Thuringian award for the best business concept for microfluidic ChipShop. In March 2006 Dr. Gärtner was named CEO for microfluidic ChipShop. She is involved in a wide variety of research projects in the field of lab-on-a-chip systems. Furthermore, she is leading several collaborative R&D aiming in the development of portable systems for the detection of B-agents.

Scanning Microscopy and Forensics

Scanning Microscopy in Forensic Science
SC954
Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Monday 8:30 am to 5:30 pm

This one day short course will be devoted to the use of scanning microscopies including scanning electron microscopy (SEM), scanning optical profilometry, and energy dispersive x-ray (EDS) and x-ray fluorescence (XRF) spectrometry to forensic sample analyses including counter terrorism, explosives, pyrotechnics, counterfeit drugs and food and product tampering. The course is presented in four sections. Section one will provide the students with an understanding of the value and pitfalls of relying on instrument software in the examination of varying samples types and analysis conditions. Emphasis will be placed on issues of instrument quality assurance including calibration, operation and understanding your instrument’s data and compliance with certification organizations including ISO and ASCLD/LAB. Section two will be devoted to a presentation of sample handling and preparation as well as “unknown white powder” case analyses and other cases involving counterfeit drugs, food and product tampering. Section three will cover the issues of gunshot residue (GSR) analysis and more “unknown white powder” analyses related to pyrotechnic devices and flares as well as a presentation on improvised acid/foil bombs. Section four will include additional approaches to the analyses of “unknown white powder” cases so common today, the capabilities of a forensic laboratory in supporting emergency responders, and a number of illustrative case histories. Additional topics may cover a Scientific Working Group on Gun Shot Residue (SWGGSR) update report and perspective on instant shooter GSR kits. This course will be jointly presented by four instructors, all recognized experts in their respective area of scanning microscopy and applications to forensic science.

LEARNING OUTCOMES
This course will enable you to:
• use a variety of techniques (many being very simple) to collect, isolate, and process suspect trace evidence particles and fibers for SEM/EDS analysis
• take back to your laboratory a number of effective tips and analytical approaches to small particle handling and analyses including the “unknown white powder”
• evaluate critical factors related to SEM/EDS calibration and how they relate to the accuracy of your measurements and subsequent analyses
• learn the state-of-the-art procedures in the analysis of GSR data by SEM/EDS
• learn the current guidelines in interpretation of GSR data
• relate and compare your personal analytical case work or quality control analyses to illustrated forensic cases and analytical approaches

INTENDED AUDIENCE
This course is directed at the laboratory analyst using scanning electron microscopy and energy dispersive x-ray spectrometry analyses as well as other types of scanning probe instrumentation in the analysis of trace evidence including unknown surfaces, individual particles, “unknown white powder” and gunshot residue. Individuals employed in other related fields including forensic laboratory accreditation, quality management, environmental sample and microchemical analyses will find this course beneficial. All analysts using SEM/EDS, regardless of their discipline, will find this course interesting and readily see how SEM/EDS analyses of forensic samples applies to many types of laboratory and environmental investigations.
This course discusses the equipment, techniques, tricks, and skills necessary to align optical systems and devices. You learn to identify errors in an optical system, and how to align lenses.

LEARNING OUTCOMES
This course will enable you to:
• determine if errors in the optical system are due to misalignment errors or other factors such as fabrication, design, or mounting problems
• recognize and understand the fundamental imaging errors associated with optical systems
• diagnose (qualitatively and quantitatively) what is wrong with an optical system by simply observing these fundamental imaging errors
• use the variety of tools available for aligning optical systems, and more importantly, how to “tweak” logically the adjustments on these devices so that the alignment proceeds quickly and efficiently
• align basic lens systems and telescopes
• align more complex optical systems such as those containing off-axis aspheric surfaces, and maintain alignment using automatic mounting techniques

INTENDED AUDIENCE
Engineers who need to solve optomechanical design problems. Optical designers will find that the course will give insight into the mechanical aspects of optical systems. The course will also interest those managing projects involving optomechanics. Short course SC001, Optical System Design: Layout Principles and Practice, or a firm understanding of its content, is required as background to this course.

INSTRUCTOR
Daniel Yakobratovich is a senior principal engineer at Raytheon. He has over 20 years of experience in optomechanics, is a founding member of the SPIE working group in optomechanics, and is fellow of SPIE. He has taught optomechanics in 11 countries, consulted with over 50 companies and written over 50 publications in optomechanics.

Introduction to Optomechanical Design
SC014
Course level: Introductory
CEU 1.30 $990 / Non-member $1110 USD
Wednesday/Thursday 8:30 am to 5:30 pm

This course will provide the training needed for the optical engineer to work with the mechanical features of optical systems. The emphasis is on providing techniques for rapid estimation of optical system performance. Subject matter includes material properties for optomechanical design, kinematic design, athermalization techniques, window design, lens and mirror mounting.

LEARNING OUTCOMES
This course will enable you to:
• select materials for use in optomechanical systems
• determine the effects of temperature changes on optical systems, and develop design solutions for those effects
• design high performance optical windows
• design low stress mounts for lenses
• select appropriate mounting techniques for mirrors and prisms
• describe different approaches to large and lightweight mirror design

INTENDED AUDIENCE
Engineers who need to solve optomechanical design problems. Optical designers will find that the course will give insight into the mechanical aspects of optical systems. The course will also interest those managing projects involving optomechanics. Short course SC001, Optical System Design: Layout Principles and Practice, or a firm understanding of its content, is required as background to this course.

INSTRUCTOR
Daniel Yakobratovich is a senior principal engineer at Raytheon. He has over 20 years of experience in optomechanics, is a founding member of the SPIE working group in optomechanics, and is fellow of SPIE. He has taught optomechanics in 11 countries, consulted with over 50 companies and written over 50 publications in optomechanics.

Introduction to Optical Alignment Techniques
SC010
Course level: Introductory
CEU 1.30 $990 / Non-member $1110 USD
Monday–Tuesday 8:30 am to 5:30 pm

This course discusses the equipment, techniques, tricks, and skills necessary to align optical systems and devices. You learn to identify errors in an optical system, and how to align lens systems.

LEARNING OUTCOMES
This course will enable you to:
• align more complex optical systems such as those containing off-axis aspheric surfaces, and maintain alignment using automatic mounting techniques

INTENDED AUDIENCE
This course is directed toward engineers and technicians needing basic practical information and techniques to achieve alignment of simple optical systems, as well as seemingly more complicated off-axis aspheric mirrors. To benefit most from this course you will need a basic knowledge of how alignment affects the performance of a lens system. For this reason, we recommend Practical Optics for Engineers, SPIE, as an essential introductory text. This course will provide the training needed for the optical engineer to work with the mechanical features of optical systems. The emphasis is on providing techniques for rapid estimation of optical system performance. Subject matter includes material properties for optomechanical design, kinematic design, athermalization techniques, window design, lens and mirror mounting.

INSTRUCTOR
Mitchell Ruda Ph.D., is president of Ruda-Cardinal, Inc., an optical engineering consulting firm, located in Tucson, Arizona. He is a fellow of SPIE.

INSTRUCTORS
S. Frank Platek is a Research Biologist in the Trace Examination Section of the U.S. FDA’s Forensic Chemistry Center. Prior to his 20 years with the FDA, he served 15 years as a research biologist with the National Institute for Occupation Safety and Health (NIOSH) specializing in SEM/TEM/EDS analysis of fine particles and fibers. Since 1993, he has been a member of the editorial review board of the Journal SCANNING and chairperson for the Scanning Microscopy in Forensic Science Session and course for the International SCANNING meeting. He has served as a national touring speaker for the Microbeam Analysis Society and the Microscopy Society of America. He lectures in Forensic Science Applications of SEM at the Lehigh University Microscopy School and has taught SEM/EDS analysis at Northern Kentucky University for over 30 years. He is a member of the American Academy of Forensic Science, Mid-Western Association of Forensic Science, Microscopy Society of America, and Microscopy Society of the Ohio River Valley.

Michael Trimpe has worked at the Hamilton County Coroner’s Lab for 31 years. He is a Past President of the Midwestern Association of Forensic Scientists and received the Distinguished Scientist Award. He conducted the FBI GSR Symposium in 2005. He is the founder and chairman of the International Scientific Working Group for Gunshot Residue. He is a Fellow member of the American Academy of Forensic Sciences, and is the recipient of the Mary E. Cowen Award in the Criminalistics Section in 2010. His other scientific memberships include the European Network of Forensic Scientists, TWGFX, and the International Association of Arson Investigators. Mr. Trimpe has taught the analysis of gunshot residue all over the country and has frequently been asked to speak at GSR seminars all over the world.

Michael McVicar is an Assistant Section Head in the Chemistry Section of the Centre of Forensic Sciences (CFS) in Toronto, Canada. He has worked as a forensic chemist at the CFS for 24 years, reporting in trace evidence casework involving glass, paint, polymers, fire debris, building materials, metals, and gunshot residue. He has applied scanning electron microscopy to trace evidence examination for over 20 years. He is a member of the Scientific Working Group for Gunshot Residue, is the Chemistry Section Chair of the Canadian Society of Forensic Science, a Member of the Technical Advisory Committee to ASCLD/LAB, an invited speaker at the 2008 ENFSI Firearms/GSR meeting, an invited speaker at the 2006 Ontario Bar Association panel discussion on Gunshot Residue, and an invited speaker at the 2005 Osgoode Hall Law School Panel on “Best Practices for Collecting, Compiling and Communicating Expert Evidence.” He was a presenter on the Forensic Applications of SEM at the 2006, 2007, and 2008 Scanning Conferences.

Michael Postek is the Chief of the Mechanical Metrology Division within the new National Institute of Standards and Technology (NIST) Physical Measurement Laboratory. Dr. Postek was the Assistant to the NIST Director for Nanotechnology and is both a nationally and internationally recognized expert in nanometrology and scanning electron microscope (SEM) critical dimension (CD) metrology.

Optical and Optomechanical Engineering
Introduction to Optical Alignment Techniques
SC010
Course level: Introductory
CEU 1.30 $990 / Non-member $1110 USD
Monday–Tuesday 8:30 am to 5:30 pm

This course discusses the equipment, techniques, tricks, and skills necessary to align optical systems and devices. You learn to identify errors in an optical system, and how to align lens systems.
Basic Optics for Engineers

SC156
Course level: Introductory
CEU .65 Member $520 / Non-member $610 USD
Monday 8:30 am to 5:30 pm

This course introduces each of the following basic areas of optics, from an engineering point of view: geometrical optics, image quality, flux transfer, sources, detectors, and lasers. Basic calculations and concepts are emphasized.

LEARNING OUTCOMES
This course will enable you to:
• compute the following image properties: size, location, fidelity, brightness
• estimate diffraction-limited imaging performance
• explain optical diagrams
• describe the factors that affect flux transfer efficiency, and their quantitative description
• compute the spectral distribution of a source
• describe the difference between photon and thermal detectors
• calculate the signal to noise performance of a sensor (D* and noise equivalent power)
• differentiate between sensitivity and responsivity
• explain the main factors of laser beams: monochromaticity, collimation, and propagation

INTENDED AUDIENCE
This class is intended for engineers, technicians, and managers who need to understand and apply basic optics concepts in their work. The basics in each of the areas are covered, and are intended for those with little or no prior background in optics, or for those who need a fundamental refresher course.

INSTRUCTOR
Alfred Ducharme is a professor of optics and electrical engineering in the College of Engineering and Computer Science at the University of Central Florida. He received a B.S. in Electrical Engineering from the University of Massachusetts - Lowell, and both a M.S. and Ph.D. in Electrical Engineering from the University of Central Florida - School of Optics (CREOL). Dr. Ducharme is the Program Coordinator for the 4-year undergraduate program in Photonics (BSEET-Photonics) offered by the Engineering Technology Department.

COURSE PRICE INCLUDES the text Basic Electro-Optics for Electrical Engineers (SPIE Press, 1998) by Glenn D. Boreman.

Introduction to Radiometry and Photometry

SC178
Course level: Introductory
CEU .35 Member $290 / Non-member $440 USD
Monday 8:30 am to 12:30 pm

In this half-day course the basic quantities of radiometry, their units, and their relationships to electro-magnetic field quantities are presented. Photometry, its units, and conversion factors to older units are also addressed. The course covers the fundamentals of blackbody radiation generation and transfer. The basic equations needed to set up and solve problems are discussed.

The course introduces radiometric and photometric sources, detectors of optical radiation, instrumentation, and calibration. The supplementary textbook, Introduction to Radiometry and Photometry by Ross McCluney, is provided with the course and offers more detail in detector optical/ electrical characterization, color theory, and optical properties of specific materials.

This course is an ideal lead-in to SC944 The Radiometry Case Files, which provides many applied examples of the concepts introduced here.

LEARNING OUTCOMES
This course will enable you to:
• learn the methodology used for quantifying and describing electromagnetic radiation from the extreme UV through the visible portions of the spectrum and into the far IR
• become conversant with the concepts, terminology, and units of both radiometry and photometry
• master key radiometric laws and approximations
• master the basics of photometry, the system of terminology and units used whenever the eye is the detector
• describe the characterization of optical properties of surfaces, materials, and objects
• gain insight into the design and calibration of radiometers and photometers

INTENDED AUDIENCE
This course is for engineers and scientists who deal with electromagnetic radiation who need to quantify this radiation using international standard units and terminology. The course is for teachers, students, and researchers interested in using proper methods, terminology, symbols, and units in their courses and their research work. It is also for practitioners solving problems in radiation transfer, and in measuring radiant and luminous flux in optical systems and in nature.

INSTRUCTOR
Barbara Grant is the co-author, with Jim Palmer, of The Art of Radiometry. For more than twenty years she has applied her engineering skills to solve problems in industries as diverse as aerospace and indoor tanning. A consultant in electro-optics, she received the M.S. degree in Optical Sciences from the University of Arizona and two NASA awards for her work on the GOES weather satellite imager and sounder. Her previous work for SPIE includes developing and chairing a special session on FLIR image analysis.

COURSE PRICE INCLUDES the text Introduction to Radiometry and Photometry (Artech House, 1994) by Ross McCluney.

Optical Alignment Mechanisms

SC220
Course level: Intermediate
CEU .35 Member $275 / Non-member $325 USD
Wednesday 8:30 am to 12:30 pm

This is a practical “how to” course dealing with the design and fabrication of precision optical alignment and adjustment devices. The course uses example optical systems to identify typical alignment requirements and provides a catalog of proven adjustment techniques.

LEARNING OUTCOMES
This course will enable you to:
• learn to assess degrees-of-freedom an optical element must have to align it in its system
• define range-of-adjustment vs. resolution-of-adjustment for these mechanisms
• identify appropriate design guidelines and pitfalls
• understand material choices, important tolerances, and mount stability
• determine where to get the hardware made

INTENDED AUDIENCE
This course is intended to help the mechanical or opto-mechanical design engineer identify and characterize the degrees-of-freedom necessary to align an optical system and to provide him with a catalog of proven configurations. While the course primarily addresses small optics, the concepts apply to larger systems as well. A general knowledge of optics is required; familiarity with optical measurement and mounting techniques is highly recommended.

INSTRUCTOR
Robert Guyer specializes in the design and manufacture of precision opto-mechanical systems/lasers, gimbaled systems, stable optical
Courses

Integrated Opto-Mechanical Analysis

SC254
Course level: Advanced
CEU .65 Member $530 / Non-member $620 USD
Thursday 8:30 am to 5:30 pm

This course presents opto-mechanical analysis methods to design, analyze, and optimize the performance of imaging systems subject to environmental influences. Emphasized is the application of finite element techniques to develop efficient and practical models for optical elements and support structures from early design concepts to final production models. Students will learn how to design, analyze, and predict performance of optical systems subject to the influence of gravity, pressure, stress, harmonic, random, transient, and thermal loading. The integration of optical element thermal and structural response quantities into optical design software including ZEMAX and CODEV is also presented that allows optical performance metrics such as wavefront error to be computed as a function of the environment and mechanical design variables. Advanced techniques including the modeling of adaptive optics and design optimization are also discussed. Examples will be drawn from ground-based, airborne, and spaceborne optical systems.

LEARNING OUTCOMES
This course will enable you to:
• efficiently model optical mounts, flexures, and metering structures
• design and analyze optical bonds including structural adhesives and RTV
• predict optical errors and line-of-sight jitter in random environments
• design and analyze vibration isolation systems
• perform thermo-elastic analysis of optical systems
• predict the effects of stress birefringence on optical performance
• develop diagnostic analyses and back-outs for test and assembly induced errors
• effectively model lightweight mirrors
• integrate thermal and structural results into optical models
• predict and represent the distortion of optical surfaces using Zernike polynomials
• model adaptive optics, predict system correctability and system performance
• use numerical optimization techniques to improve designs

INTENDED AUDIENCE
This course is intended for mechanical and optical engineers interested in learning opto-mechanical analysis techniques and the use of modern software tools including finite element analysis and optical design software to design and analyze optical systems. Working knowledge or familiarity with finite element software and/or optical design software is recommended.

INSTRUCTORS
Victor Genberg has over 40 years' experience in the application of finite element methods to high-performance optical structures and is a recognized expert in opto-mechanics. He is currently President of Sigma-dyne, Inc. and a Professor of Mechanical Engineering at the University of Rochester where he teaches courses in optomechanics, finite element analysis, and design optimization. He has over 40 publications in this field including two chapters in the CRC Handbook of Optomechanical Engineering. Prior to founding Sigma-dyne, Dr. Genberg spent 28 years at Eastman Kodak serving as a technical specialist for military and commercial optical systems.

Keith Doyle has 20 years' experience in the field of optical engineering, specializing in opto-mechanics and the multidisciplinary modeling of optical systems. He has authored or co-authored over 30 publications in this field. He is currently employed as an Assistant Group Leader of the Engineering Analysis Group at MIT Lincoln Laboratory. Previously he served as Vice President of Sigma-dyne Inc. and as a Senior Systems Engineer at Optical Research Associates. He received his Ph.D. in engineering mechanics with a minor in optical sciences from the University of Arizona in 1993.


Understanding Reflective Optical Design

SC659
Course level: Intermediate
CEU .65 Member $480 / Non-member $570 USD
Thursday 8:30 am to 5:30 pm

This course provides attendees with a working knowledge of reflective optical system design. The morning session concentrates on analytical differences from refractive systems, including basic 1st order layout considerations and optimization techniques. It provides an overview of the conceptual development of various reflective designs, and provides an understanding of the basic capabilities, advantages and disadvantages of many common reflective forms. The afternoon session offers insights into departing from symmetry, understanding aberration forms with off axis apertures, a discussion of segmented mirror systems, and a brief overview of assembly and test considerations and manufacturing techniques.

LEARNING OUTCOMES
This course will enable you to:
• develop and analyze the appropriate set of 1st order parameters for reflective systems
• identify the advantages and constraints of various common reflective forms
• list analysis parameters unique to reflective system design
• trace the logical progression of reflective system from the single to multiple mirrors
• establish reasonable starting point layouts for 3 mirror design forms
• identify situations that may call for departing from symmetry in the design and understand the advantages and limitations of this technique
• recognize aberration forms in off-axis apertures and how to mitigate them
• classify the basic advantages and constraints of designs with segmented mirrors
• identify key strategies for integration I&T of reflective architectures
• describe fundamental manufacturing techniques and considerations, including diamond turning methods and mirror material properties

INTENDED AUDIENCE
This material is intended for anyone who needs to design or specify reflective optical systems, or who works with optical designers on a regular basis. A basic understanding of 1st order optics is helpful; a brief overview will be provided. No optical design experience is required, but a basic knowledge of optical aberrations will be assumed for the optical design specific discussions. The more in depth, design oriented portions of the course will include summary information valuable to engineers in non-optical disciplines. Those who have either little optical design experience or just minimal reflective design experience will find this course especially valuable.

INSTRUCTOR
James Contreras is a principal optical engineer at Exotic Electro-Optics, a subsidiary of II-VI Incorporated in Murrieta, CA. He has extensive experience in the design, analysis and fabrication of reflective optical systems for a variety of applications ranging from military platforms to the James Webb Space Telescope. His current projects include conceptual optical design of multiple wavelength band sensors for military and commercial applications, design for manufacturability of existing products, and investigation of replicated mirror technologies.
Infrared Optics and Zoom Lenses

SC755

Course level: Intermediate

CEU .35 Member $320 / Non-member $370 USD

Thursday 8:30 am to 12:30 pm

This course describes the fundamental properties of the infrared region of the spectrum and explains the techniques involved in the design and analysis of representative infrared zoom lenses. The use of computer optimization is discussed with examples to illustrate the step-by-step development of any optical system and zoom lenses in particular. It gives attendees an insight into zoom lens characteristics in general and the design and analysis process involved in developing an infrared zoom lens system. Civil and military applications are discussed which match the optics with infrared detectors and sensors. Recent trends include the advent of focal plane arrays and the shift to the near infrared spectral region. 32 refractive zoom lens systems and 9 representative reflective zoom systems are presented, along with many new diagrams.

LEARNING OUTCOMES

After completing this course, attendees will be able to:

• describe the fundamental properties of zoom lenses as to whether they are mechanically or optically compensated and with regard to positive or negative moving groups
• describe the relevant issues that are unique to the infrared region of the spectrum, including sources, detectors, CCD arrays, optical materials, thermalization, narcissus, and coatings
• gain an insight into the optical design techniques utilized in the design of infrared zoom lenses, including achieving high magnification ratios, achromatization, aberration control, the use of aspherics and diffractive optical elements, compactness techniques, computer optimization, global search, scaling, and tolerances
• classify infrared zoom lenses according to their application: scanning telescopes, target simulators, surveillance systems, target recognition, battlefield detection, imaging systems, solar observatories, laser beam expanders, and cell phone cameras
• establish requirements for your particular application
• decide whether a given zoom lens optical system meets your requirements and matches the capabilities of the detector

INTENDED AUDIENCE

This course is for engineers and scientists interested in learning more about the infrared region of the spectrum and about infrared zoom lenses and their applications.

INSTRUCTOR

Allen Mann has over forty years’ experience in the design and analysis of optical systems, including visual and infrared zoom lenses. Mr. Mann has written several papers on the subject of infrared zoom lenses and is the editor for the SPIE Milestone Volume on Zoom Lenses. He was chairman of SPIE Zoom Lens Conference I and co-chair of Zoom Lens Conference II. He is retired from Hughes Aircraft Company and is now an independent consultant. Mr. Mann has been elected to be a Fellow of SPIE.


Optomechanical Analysis

SC781

Course level: Advanced

CEU .65 Member $480 / Non-member $570 USD

Wednesday 8:30 am to 5:30 pm

This course teaches the basic requirements for accurately predicting the influences of thermal, structural and servo system designs on the performance and quality of optical imaging systems. It is based upon the instructor’s forty years’ experience in designing, analyzing and building complex optical systems, especially for the Federal market place. It incorporates elements from some of his earlier tutorials, “Finite Ele-
INTENDED AUDIENCE
This class is designed for the practicing engineer or technologist who is expected to solve radiometric problems but is unsure what factors to identify in formulating a solution, or where to locate examples of similar problems. Though taught at an introductory level, the course assumes a basic familiarity with radiometric terminology.

INSTRUCTOR
Barbara Grant is the co-author, with Jim Palmer, of The Art of Radiometry. For more than twenty years she has applied her engineering skills to solve problems in industries as diverse as aerospace and indoor tanning. A consultant in electro-optics, she received the M.S. degree in Optical Sciences from the University of Arizona and two NASA awards for her work on the GOES weather satellite imager and sounder. Her previous work for SPIE includes developing and chairing a special session on FLIR image analysis.

COURSE PRICE INCLUDES the text The Art of Radiometry (SPIE Press, 2009) by James M. Palmer and Barbara G. Grant.

Cost-Conscious Tolerancing of Optical and IR Systems

SC947

Course level: Introductory

CEU .65 Member $480 / Non-member $570 USD

Wednesday 8:30 to 5:30 pm

The purpose of this course is to present concepts, tools, and methods that will help attendees determine optimal tolerances for opto-mechanical systems in optical applications. Detailed topics in the course apply to all volumes of systems being developed - from single systems to millions of units. The importance of tolerancing throughout the design process is discussed in detail, including determining robustness of the specification and design for manufacture and operation. The course also provides a background to effective tolerancing with discussions on variability and relevant applied statistics. A treatment of third-order aberrations is included, with emphasis on understanding their origins and how to influence cost and production yield by considering their impacts. Tolerance analysis and assignment with strong methodology and examples are discussed, including the development of a design trade for a simple IR system. References and examples are included to help researchers, designers, engineers, and technicians practically apply the concepts to plan, design, engineer, and build high-quality cost-competitive optical systems.

LEARNING OUTCOMES
This course will enable you to:
- identify key system requirements for tolerancing
- develop insight into cost and sensitivity factors early in the design process
- define variability and comprehend its impact on nominal systems
- utilize fundamental applied statistics in tolerancing
- construct tolerance analysis budgets
- perform detailed tolerance analysis
- summarize different design of experiment and statistical process control strategies

INTENDED AUDIENCE
This material is intended for engineers, technicians, and technical staff involved in product design from concept through manufacturing.

INSTRUCTORS
Richard Youngworth Ph.D. is the Director of Optical Engineering at Light Capture, Inc., an optical and optomechanical design firm providing consulting, innovation incubation, and product development services. His industrial experience spans diverse topics including optical metrology, design, manufacturing, and analysis. In particular, Dr. Youngworth has spent significant time working on optical systems in the challenging transition from ideal design to successful volume manufacturing. He is widely considered an expert, due to his research, lectures, publications, and industrial work on the design, producibility, and tolerance analysis of optical components and systems. He has a B.S. in electrical engineering from the University of Colorado at Boulder and earned his Ph.D. in optics at the University of Rochester by researching tolerance analysis of optical systems.

James Contreras is a Principal Optical Engineer at Exotic Electro-Optics in Murrieta, CA, where he serves as the project lead for all opto-mechanical assembly projects. He has extensive experience in the design, analysis and fabrication of reflective and refractive optical systems for a variety of applications ranging from tactical military platforms to the James Webb Space Telescope. His primary expertise is in reflective and IR optical design, specializing in design for manufacturability. He is actively involved in teaching for SPIE and mentoring junior engineers. He was trained in Physics at Rensselaer Polytechnic Institute (B.S.) and the Georgia Institute of Technology (M.S.); the majority of his career has been in the defense and aerospace industry at companies such as Hughes Aircraft Company and Ball Aerospace Corp.

Infrared Imaging Radiometry

SC950

Course level: Advanced

CEU .65 Member $480 / Non-member $570 USD

Tuesday 8:30 am to 5:30 pm

This course will enable the user to understand how an infrared camera system can be calibrated to measure radiances and/or temperatures and how the digital data is converted into radiometric data. The user will learn how to perform their own external, “by hand” calibrations on a science-grade infrared camera system using area or cavity blackbodies and an Excel spreadsheet provided by the instructor. The influences of lenses, ND and bandpass filters, windows, emissivity, reflections and atmospheric absorption on the system calibration will be covered. The instructor will use software to illustrate these concepts and will show how to measure emissivity using an infrared camera and how to predict system performance outside the calibration range.

LEARNING OUTCOMES
This course will enable you to:
- classify the measurement units of radiometry and thermography
- describe infrared camera transfer functions - electrical signal output versus radiance signal input
- determine which cameras, lenses and both cold and warm filters to select for your application
- assess effects of ND filters and bandpass filters on calibrations, and calculate which ND warm filter you need for a given temperature range of target
- perform radiometric calibration of camera systems using cavity and area blackbodies
- convert raw data to radiometric data, and convert radiometric data to temperatures
- measure target emissivity and calibrate emissivity into the system
- gauge and account for reflections and atmospheric effects on measurements

INTENDED AUDIENCE
This material is intended for engineers, scientists, graduate students and range technicians that are working with science-grade infrared cameras in the lab, on military test ranges, or similar situations.

INSTRUCTOR
Austin Richards is a senior research scientist at FLIR Commercial Vision Systems in Santa Barbara, and has specialized in scientific applications of infrared imaging technology for over 9 years. He holds a Ph.D. in astrophysics from UC Berkeley and is the author of the SPIE monograph Alien Vision: Exploring the Electromagnetic Spectrum with Imaging Technology.
Introduction to Infrared and Ultraviolet Imaging Technology

SC1000

Course level: Introductory
CEU .35 Member $310 / Non-member $360 USD
Monday 1:30 to 5:30 pm

The words infrared and ultraviolet are coming into much more widespread use, as ideas about the technology penetrates the public’s awareness and becomes part of popular culture through TV and film. In industry and academia, applications for infrared and ultraviolet cameras are multiplying rapidly, because both of the continued reduction in system cost as the technology penetrates the commercial marketplace, and the forward march of technology. At the same time, there is a fairly limited body of information about applications for these cameras. This is because camera manufacturers tend focus on the products themselves, not applications, and because most textbooks on IR and UV technology are outdated and tend to emphasize the basics of radiometry and detection by single detectors, not imaging applications.

This course gives a non-technical overview of commercial infrared and ultraviolet camera systems, the “taxonomy” of infrared and ultraviolet wavebands, and the wide variety of applications for these wavebands. The course relies heavily on interesting imagery captured by the presenter over the last ten years and uses a SPIE monograph written by the author as a supplementary textbook.

LEARNING OUTCOMES
This course will enable you to:
• identify the different wavebands of the infrared and ultraviolet spectrum and describe their differences
• gain familiarity with the different types of cameras, sensors and optics used for imaging in the infrared and ultraviolet wavebands
• describe some of the key imaging applications for different wavebands of the infrared and ultraviolet

INTENDED AUDIENCE
The course is suitable both for technology professionals and non-technical persons that are new to infrared and ultraviolet imaging and want a very basic, qualitative overview of the fields with minimal mathematics. Little to no mathematical background is required.

INSTRUCTOR
Austin Richards is a senior research scientist at FLIR Systems in Santa Barbara, CA. He holds a PhD in Astrophysics from UC Berkeley, and has worked in the commercial infrared industry for over 10 years. He is also the CTO of Oculus Photonics, a small company devoted to near-ultraviolet imaging systems manufacturing, sales and support. Richards is the author of the SPIE monograph Alien Vision: Exploring the Electromagnetic Spectrum with Imaging Technology and an adjunct professor at the Brooks Institute of Photography in Santa Barbara.


Basic Optics for Non-Optics Personnel

WS609

Course level: Introductory
CEU .20 $100 / Non-member $150 USD
Tuesday 1:30 to 4:00 pm

This course will provide the technical manager, sales engineering, marketing staff, or other non-optics personnel with a basic understanding of the terms, specifications, and measurements used in optical technology to facilitate effective communication with optics professionals on a functional level. Topics to be covered include basic concepts such as interference, diffraction, polarization and aberrations, definitions relating to color and optical quality, and an overview of the basic measures of optical performance such as MTF and wavefront error. The material will be presented with a minimal amount of math, rather emphasizing working concepts, definitions, rules of thumb, and visual interpretation of specifications. Specific applications will include defining basic imaging needs such as magnification and depth-of-field, understanding MTF curves and interferograms, and interpreting radiometric terms.

LEARNING OUTCOMES
This course will enable you to:
• read and understand optical system descriptions and papers
• ask the right questions about optical component performance
• describe basic optical specifications for lenses, filters, and other components
• select the right off-the-shelf lenses, filters, and beam directing optics
• interpret optical data such as interferogram, MTF and aberration reports

INTENDED AUDIENCE
This course is intended for the non-optical professional who needs to understand basic optics and interface with optics professionals.

INSTRUCTOR
Kevin Harding has been active in the optics industry for over 30 years, and has taught machine vision and optical methods for over 25 years in over 70 workshops and tutorials, including engineering workshops on machine vision, metrology, NDT, and interferometry used by vendors and system houses to train their own engineers. He has been recognized for his leadership in optics and machine vision by the Society of Manufacturing Engineers, Automated Imaging Association, and Engineering Society of Detroit. Kevin is a Fellow of SPIE and was the 2008 President of the Society.
Business & Professional Development

Advanced Topics in U.S. International Trade Regulations

WS1037

Course level: Intermediate
CEU .35 Member $275 / Non-member $325 USD
Thursday 8:30 am to 12:30 pm

U.S. businesses are subject to increasing regulatory controls on the export of their products, services and technical data, as well as their sales activities in foreign jurisdictions. Recent increases in penalty amounts and coordination among federal agencies have sharpened the ability of export enforcement authorities to target wrongdoers. These developments coincide with a dramatic up-tick in investigative and enforcement activity involving businesses of every size.

During this fast-paced program, you will be provided with cutting edge information designed to forestall enforcement activities against your company. Real world situations and lessons learned will be provided, as well as practical tips on best practices.

LEARNING OUTCOMES
This course will enable you to:
• acquire a big-picture overview of the Export Administration Regulations, International Traffic in Arms Regulations, Antiboycott Regulations, and the Foreign Corrupt Practices Act, and how each regulatory regime impacts both your domestic and foreign activities
• establish methods for determining which regulatory regime applies to your business activities, both domestic and foreign
• develop the key ingredients of an effective compliance program to deal with the full panoply of U.S. international trade laws and regulations
• review recent enforcement trends and lessons learned from recent enforcement actions
• review the current status of U.S. export control reform efforts and future prospects
• avoid pitfalls and grow your business free of enforcement activity

INTENDED AUDIENCE
Owners, executives, scientists, engineers, and technicians that wish to learn how to grow business while effectively and efficiently navigating U.S. international trade laws and regulations. This course expands upon WS933 Complying with the ITAR: A Case Study. Attendance at WS933 is helpful but not a prerequisite.

INSTRUCTOR
Kerry Scarlott is a Director at the law firm of Goulston & Storrs, and is an industry leader in International Trade, Export Controls and Compliance. His practice, based in Boston, MA and Washington, D.C., focuses on business law and international trade law, with particular expertise in assisting technology-based companies. He serves as general outside counsel to companies and entrepreneurs, providing guidance in connection with entity formation, debt and equity financings and private offerings, mergers and acquisitions, day-to-day commercial contract matters, strategic alliances, private label manufacturing, and intellectual property protection and utilization. Kerry has particular expertise in counseling technology-based clients in navigating the Export Administration Regulations (EAR) and the International Traffic in Arms Regulations (ITAR). He lectures and writes regularly on international trade matters, including export compliance, foreign distribution and sale of products, and related topics.

Complying with the ITAR: A Case Study
WS933

Course level: Introductory
CEU .35 Member $275 / Non-member $325 USD
Wednesday 8:30 am to 12:30 pm

In the world of international trade, it’s what you don’t know that can hurt you. With the U.S. government’s focus on homeland security and its increasing reliance on photonics for the development and production of defense-related products and services, your activities may well be subject to the ITAR.

This workshop will begin with a brief contextual overview of U.S. export controls, including the Export Administration Regulations, the ITAR, and special sanction programs administered by the Treasury Department’s Office of Foreign Assets Control. We will then transition into a case study focused on the ITAR. Real world situations and lessons learned will be shared. Various aspects of the case study will likely be familiar to you in the context of your own experiences, allowing you to learn effectively how to spot ITAR issues before they negatively impact your business.

You will also learn about current enforcement trends and best practices for avoiding violations.

LEARNING OUTCOMES
This course will enable you to:
• determine at least on a preliminary basis whether your products, services and/or technical data are subject to the ITAR
• know when a deemed export might arise and what to do about it
• communicate effectively with government and private contracting entities, including prime and subprime contractors, in order to know when the ITAR may apply
• determine what type of government license or approval must be obtained in particular circumstances
• implement best practices to handle ITAR-controlled products, services or technical data and avoid negative enforcement outcomes

INTENDED AUDIENCE
Owners, executives, managers and engineers engaged in photonics research, development or manufacturing activities.

INSTRUCTOR
Kerry Scarlott is a Director at the law firm of Goulston & Storrs. With an office in Boston, MA and Washington, D.C., Kerry focuses his practice on business law and international trade law, with particular expertise in assisting technology-based companies. He serves as general outside counsel to companies and entrepreneurs, providing guidance in connection with entity formation, debt and equity financings and private offerings, mergers and acquisitions, day-to-day commercial contract matters, strategic alliances, private label manufacturing, and intellectual property protection and utilization. Kerry has particular expertise in counseling technology-based clients in navigating the Export Administration Regulations (EAR) and the International Traffic in Arms Regulations (ITAR). He lectures and writes regularly on international trade matters, including export compliance, foreign distribution and sale of products, and related topics.
Leading Successful Product Innovation

WS951
Course level: Intermediate
CEU .35 Member $275 / Non-member $325 USD
Tuesday 8:30 am to 12:30 pm

The fundamental goal of this course is to answer the question: “How do I take an idea off the white-board and turn it into a windfall product?” We will explore and apply the principles of good leadership to create a culture of excellence within your organization—the most basic ingredient for success. A special emphasis will be placed on learning how to develop and construct an effective new project pitch using the instructor’s “Disciplined Creativity” concept and framework. We will then describe the “Spiral Development Process” for rapid, effective, and successful prototype development, followed by an in-depth examination of the life-cycle approach to product development. This course will also enable you to conduct a “red teaming” exercise to identify competitive threats, identify weaknesses in your company, and most importantly, develop solution strategies. We will also place an emphasis on how to properly vet an idea and how to ask tough-minded questions designed to ferret out shortcomings.

LEARNING OUTCOMES
This course will enable you to:
• apply the key principles of leadership to create a culture of excellence for your organization
• develop a project “pitch” to champion your idea with venture capitalists, and funding agencies
• construct a “spiral development” process that is executable, manageable, and successful
• identify best practices for the life-cycle approach to product management
• conduct a “red teaming” exercise
• apply the principles of strategic planning to develop a successful technology roadmap
• conduct an “After Action Review” and distill out critical “lessons learned”
• demonstrate how to run an effective meeting
• formulate a “product requirements document”
• demonstrate effective project management skills
• define and list the key elements of “Design for Manufacturing”

INTENDED AUDIENCE
This course is intended for R&D managers at all levels. It is also appropriate for other senior department managers with responsibility for aspects of product development (e.g. marketing, manufacturing, business development). Start-up companies, or anyone contemplating starting their own venture will find the material relevant and useful. Scientists and engineers aspiring to management track positions will also benefit from this course.

INSTRUCTOR
John Carrano is President of Carrano Consulting. Previously, he was the Vice President, Research & Development, Corporate Executive Officer, and Chairman of the Scientific Advisory Board for Luminex Corporation, where he led the successful development of several major new products from early conception to market release and FDA clearance. Before joining Luminex, Dr. Carrano was as a Program Manager at DARPA, where he created and led several major programs related to bio/chem sensing, hyperspectral imaging and laser systems. He retired from the military as a Lieutenant Colonel in June 2005 after over 24 years’ service; his decorations include the “Defense Superior Service Medal” from the Secretary of Defense. Dr. Carrano is a West Point graduate with a doctorate in Electrical Engineering from the University of Texas at Austin. He has co-authored over 50 scholarly publications and has 3 patents pending. He is the former DSS Symposium Chairman (2006-2007) and is an SPIE Fellow.

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Sign up today
Course fees
increase after
8 April 2011

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