## Program overview

### Year
2008/2009

### Organization
Applied Sciences

### Education
Master Applied Physics

<table>
<thead>
<tr>
<th>Code</th>
<th>Omschrijving</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP3381</td>
<td>Specialization Astronomy and Instrumentation (AI)</td>
<td>6</td>
</tr>
<tr>
<td>AP3901</td>
<td>Specialization Astronomy and Instrumentation (AI)</td>
<td>48</td>
</tr>
<tr>
<td>ET4283</td>
<td>Specialization Astronomy and Instrumentation (AI)</td>
<td>6</td>
</tr>
<tr>
<td>WM0320TN</td>
<td>Specialization Astronomy and Instrumentation (AI)</td>
<td>3</td>
</tr>
</tbody>
</table>

### Specialization Astronomy and Instrumentation (AI) AP 2008

- **AP3381**: Theoretical Optics
- **AP3901**: Master Thesis Applied Physics
- **ET4283**: Seminar Advanced Digital Image Processing
- **WM0320TN**: Ethics and Engineering

### G-list (General)

- D-list (Department)
- G, D, R of M-list

### S-list
<table>
<thead>
<tr>
<th>Year</th>
<th>2008/2009</th>
</tr>
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<tbody>
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<td>Organization</td>
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<td>Education</td>
<td>Master Applied Physics</td>
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</table>

**Specialization Astronomy and Instrumentation (AI) AP 2008**
### AP3381  Theoretical Optics

<table>
<thead>
<tr>
<th>Course Content</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electromagnetic principles, light in anisotropic media, diffraction theory, paraxial approximation, wave-optics analysis of lenses, superresolution.</td>
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</tbody>
</table>

- Choice out of the following subjects (varies per year):
  - Coherence of light, imaging with partial coherent light, lasers and Gaussian beams, rigorous diffraction theory, electromagnetic scattering problems, plasmons, nonlinear optics, phase-conjugation, self-focusing, optical solitons.

### AP3901  Master Thesis Applied Physics

<table>
<thead>
<tr>
<th>Course Content</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>The Master Thesis Project is the final part of your education as a Master of Science in Applied Physics. You should show that you are able to use the knowledge and the abilities acquired in the other parts of your education in doing scientific research and development at the frontier of modern applied physics. The aim is to execute a project within the research field of applied physics on your own with clear engineering aspects such as the analysis, design, implementation and use of algorithms, systems, methods and techniques.</td>
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</tbody>
</table>

**Study Goals**

- Application and integration of existing knowledge and abilities.
- Problem oriented learning of new knowledge and abilities, for example:
  - Effective and efficient collecting of needed information,
  - Understanding the essence of a complex problem,
  - Distinguishing the solvable from the unsolvable within given boundary conditions (time, money, people, ethical and environmental acceptability),
  - Cooperating in an applied physics research and development group.
- Reporting orally and in writing.

**Education Method**

- Individual Project in a Research Group

**Literature and Study Materials**

- Differs per project

**Assessment**

- End report (Master Thesis), Public Talk, Examination by Committee

The final mark is based on the way you have carried out the work during the project period, the results you have obtained, the written project report, the oral (public) presentation and the oral exam before the examination committee. (The presentation may be for a limited audience if the final project should be kept confidential because of propriety of knowledge/results).

**Remarks**

- Certain steps need to be taken when carrying out a Thesis Project.
- Please, consult blackboard (Thesis Project Administration) for detailed information and additional forms. Enroll to this blackboard by Organizations >> Education >> Applied Sciences >> Eindprojecten Administratie TNW.
- The procedure of a Thesis Project consists of the following steps:
  1. Orientation
  2. Careful consideration of different sections
  3. Handing in the application form and a list of the achieved courses
  4. Providing the Thesis Project Administration with the names of the review committee
  5. Presentation
  6. Assessment and calculation of the examination mark

- Pay attention!! The final mark will only be registered after the Thesis Project Administration has received a digital copy of the thesis report and survey.

For questions & handing in digital versions of the report, contact eindprojecten-tnw@tudelft.nl
### Course Contents

Image restoration (inverse filtering, Wiener filtering, geometric transformation), advanced morphological image processing and extension to grey-scale images, data-driven image segmentation (boundary detection, region-based segmentation, watersheds), model-based image segmentation (Hough transform, template matching, deformable templates, active contours), representation and description of image objects, image features (structure tensor, local shape), camera calibration (intrinsic and extrinsic parameters, projection matrix), stereopsis (correspondence, epipolar geometry, essential and fundamental matrix), motion estimation (optical flow, feature-based techniques).

### Study Goals

**General learning outcomes:**

The student has insight into state of the art algorithms for image processing including Multi-Resolution Image Processing, Morphological Image Processing, Image Features Representation/Description, Motion Estimation and Optic Flow, Image Restoration, Image Segmentation and 3D Computer Vision. The student is able to read, discuss, summarize and comment on scientific journal and conference papers in this area.

**Specific learning outcomes:**

1. **Multi-resolution Image Processing:**
   - Gaussian scale space, windowed Fourier transform, Gabor filters, multi-resolution systems (pyramids, subband coding and Haar transform), multi-resolution expansions (scaling functions and wavelet functions), wavelet Transforms (Wave series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform (CWT), Fast Wavelet Transform (FWT)).
   - The student is able to motivate the use of space-frequency representations, analyze the behavior of space-frequency techniques, explain the principles behind, classify and evaluate multi-resolution techniques.

2. **Morphological Image Processing:**
   - Definitions of gray-scale morphology: erosion, dilation, opening, closing; Application of gray-scale morphology: smoothing, gradient, second derivatives (top hat), morphological sieves (granulometry).
   - The student is able to apply, recognize the principles and analyze (a sequence of) morphological operations for noise suppression, edge detection, and sharpening.

3. **Image Feature Representation and Description:**
   - Measurement principles: accuracy vs. precision; Size measurements: area and length (perimeter); Shape descriptors of the object outline: form factor, sphericity, eccentricity, curvature signature, bending energy, Fourier descriptors, convex hull, topology; Shape descriptors of the gray-scale object: moments, PCA, intensity and density; Structure tensor in 2D and 3D: Harris Stephens corner detector, iso/phot curvature.
   - The student is able to comprehend and explain the properties of measurements in digitized images, combine measurement principles to solve a new problem, comprehend the structure tensor in various notations and apply it in measurement procedures.

4. **Motion and optic flow:**
   - Motion is structure in spatio-temporal images; Two frame registration: Taylor expansion method; Multi-frame registration: Optic Flow. Applications of image registration.
   - The student is able to explain the properties of image registration and optic flow and comprehend the aperture problem in optic flow.

5. **Image Restoration:**
   - Noise filtering, Wiener filtering, Inverse filtering, Geometric transformation, Grey value interpolation.
   - The student is able to discuss the use of linear and non-linear noise filters, explain the use of inverse filters and problems of inverse filtering in the case of noise, describe (the use of) a Wiener filter and apply geometric transformations and bi-linear grey value interpolation.

6. **Image Segmentation:**
   - Thresholding, edge and contour detection, data-driven and model-driven image segmentation, edge tracking.
   - The student is able to discuss isodata thresholding, optimal thresholding, multimodal thresholding and adaptive thresholding techniques, apply Gaussian derivative filters and difference based filters for calculation of edge point candidates, explain the trade off between localization and detection of edges, discuss split and merge techniques and edge tracking techniques. The student has insight into model-based image segmentation (object detection) approaches like template matching, Hough Transform, Deformable Template matching, Active Contours and Active Shape models and is able to formulate how shape information and image intensity information can be incorporated into these approaches.

7. **3D Computer Vision:**
   - Pinhole model, Camera Calibration, Epipolar Geometry, Correspondence Estimation.
   - The student is able to specify internal and external camera parameters.

### Literature and Study Materials

- PDF-files of the lecture slides (see blackboard)

### Assessment

- Written exam and assignment

### Exam Hours

- There will be a 2 hour written examination in the exam period after the first semester. The assessment of the assignment will take place at the end of the first semester or in the exam period after the first semester.

### Permitted Materials during Tests

- Books, print-out of pdf files of the lecture slides and lecture notes are not permitted during the written examination
<table>
<thead>
<tr>
<th>WM0320TN</th>
<th>Ethics and Engineering</th>
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<tbody>
<tr>
<td><strong>Module Manager</strong></td>
<td>Dr. D.R. Koepsell</td>
</tr>
<tr>
<td><strong>Contact Hours / Week</strong></td>
<td>4/0/0/0 or 0/0/4/0</td>
</tr>
<tr>
<td><strong>Education Period</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Start Education</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Exam Period</strong></td>
<td>1</td>
</tr>
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<td><strong>Course Language</strong></td>
<td>English</td>
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<td><strong>Course Contents</strong></td>
<td>This course is identical to the initial part of the course wm0329tu. You will explore the ethical and social aspects and problems related to technology and to your future work as professional or manager in the design, development, management or control of technology. You will be introduced to and make exercises with a range of relevant aspects and concepts, including professional codes, collective reasoning, philosophical ethics, collective decision making (public choice), ethical aspects of technological risks, responsibility within organisations, responsible conduct of companies and the role of law, and game theory as a tool for analyzing ethical problems and solutions. You will analyse legal, political and organisational backgrounds to existing and emerging ethical and social problems of technology, and you will explore possibilities for resolving, diminishing or preventing these problems.</td>
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<td><strong>Study Goals</strong></td>
<td>After having completed the course you: can better recognise and analyse ethical and social aspects and problems inherent in technology and in the work of professionals and managers active in the design, development, management and control of technology. have insight into how these ethical and social aspects and problems are related to legal, political and organisational backgrounds. are able to explore and assess possibilities for solving or diminishing existing and emerging ethical and social problems that attach to technology and the work of professionals and managers. are better prepared to perform your future work as a professional or manager in the design, development, production and control of technology in an ethical and socially responsible way.</td>
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<td><strong>Education Method</strong></td>
<td>A series of 9 lectures and work sessions (including role playing sessions) concluded with a written test.</td>
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<td><strong>Literature and Study Materials</strong></td>
<td>Reader and exercise book Ethics and Engineering, available at Nextprint and as PDF files on Blackboard; Powerpoint lecture notes.</td>
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<td><strong>Assessment</strong></td>
<td>Written exam.</td>
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<td><strong>Enrolment / Application</strong></td>
<td>Enrolment via Blackboard is required for this course. This is needed in order to plan the number of workgroups. For participation in the first period you must enrol not later than August 18 2008 and for participation in the third period not later than January 12 2009 via Blackboard.</td>
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<td><strong>Remarks</strong></td>
<td>The course is run twice each year in the first and third quarter. The course is identical to the initial part of the course wm0329tu (6 ects). The latter course continues with the writing of an essay in groups of 5 under the guidance of the teachers. Students who take wm0320tn have the possibility to also take the second part of wm0329tu, the writing of an essay. If successful this will render 3 additional ects credit points, which will be administered under the course code wm0323tn (Essay). Students who want to take wm0320tn should enrol on Blackboard both for wm0320tn (for registration purposes) and for wm0329tu (because the latter site is used for all communication purposes).</td>
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</table>
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